INDIAN CORN.

Of the cereal productions of the country Indian corn stands first in amount, much exceeding the sum of a the others, the census returns showing the crop of 1879 to have an acreage of 62,368,869 acres, producin 1,754,861,535 bushels; the acreage being 52.6 per cent. of all the land sown to grain, and the production amountin to 35 bushels per head of total population. According to the estimate of the Agricultural Department, the crop c 1879 was 11.5 per cent. greater than that of 1878, and 15.3 per cent. greater than that of 1877.

The amount produced and average per head of total population at the several census enumerations is a follows:

TABLE XLVIII.—INDIAN CORN PRODUCTION PER HEAD.

Crop year.	Bushels.	Bushels per head of population.
1879	1,754,861,535	35.0
1869	760,944,549	19.7
1859	838,792,742	20.7
1849	592,071,104	25.5
1839	377,531,875	22.1

The following is the estimated acreage and production of corn by the United States Department of Agricultur for the respective years:

TABLE XLIX.—ESTIMATED ACREAGE AND PRODUCTION OF INDIAN CORN.

Year.	Acres.	Bushels.	Year.	Acres.	Bushels.
1880	52,695,031	1,537,535,000	1874	41,036,918	850,148,500
1870	53,085,450	1,547,901,790	1873	30,197,148	932,274,000
1878	51,585,000	1,388,218,750	1872	35,526,836	1,092,710,000
1877	50,369,113	1,342,558,000	1871	34,091,137	991,898,000
1876	49,033,364	1,283,827,500	1870	38,046,977	1,094,255,000
1875	44,841,371	1,321,069,000			

While this cereal is more generally distributed over the country than any other, the place of its greatest production is on the fertile prairies and river bottoms of the West and north of the thirty-sixth parallel of latitude, where all the conditions of its profitable growth exist in better combination than is found elsewhere in the United States, or probably elsewhere in the world. The actual distribution of the crop can be better understood by an examination of the accompanying maps than by any mere verbal description. The distribution by states, in the order of their production, with the percentages and other data pertaining thereto, is given in the following table:

TABLE L.—INDIAN CORN CROP OF 1879 (CENSUS OF 1880).

No.	States.	Acres.	Bushels.	Per cent. of total product.	Cumulative per cent.	No.	States.	Acres.	Bushels.	Per cent. of total product.	Cumulative per cent.
1	Illinois	9,019,381	325,792,481	18.56	18.56	26	Louisiana	742,728	9,006,189	0.56	98.81
2	Iowa	6,616,144	275,024,247	15.67	34.23	27	Delaware	202,120	8,804,264	0.22	99.03
3	Missouri	5,588,265	202,485,723	11.54	45.77	28	Florida	360,294	3,174,294	0.18	99.21
4	Indiana	3,678,420	115,482,300	6.58	52.35	29	Vermont	55,240	2,014,271	0.11	99.32
5	Ohio	3,281,923	111,877,124	6.38	58.73	30	Dakota	90,852	2,000,864	0.11	99.43
6	Kansas	3,417,817	105,720,325	6.02	64.75	31	California	71,781	1,993,325	0.11	99.54
7	Kentucky	3,021,176	72,852,263	4.15	68.90	32	Connecticut	55,706	1,880,421	0.11	99.65
8	Nebraska	1,030,660	65,450,135	3.73	72.63	33	Massachusetts	53,344	1,797,503	0.10	99.75
9	Tennessee	2,904,873	62,704,429	3.58	76.21	34	New Hampshire	36,612	1,350,248	0.08	99.83
10	Pennsylvania	1,373,270	45,821,531	2.61	78.82	35	Maine	30,997	960,633	0.05	99.88
11	Wisconsin	1,015,393	34,230,579	1.95	80.77	36	New Mexico	41,449	633,786	0.04	99.92
12	Michigan	919,792	32,461,452	1.85	82.62	37	Colorado	22,991	455,068	0.03	99.95
13	Virginia	1,767,567	29,106,661	1.66	84.28	38	Rhode Island	11,893	372,007	0.02	99.97
14	Texas	2,408,587	29,065,172	1.65	85.94	39	Utah	12,007	163,342	0.01	99.98
15	North Carolina	2,305,419	28,019,839	1.60	87.54	40	Oregon	5,646	126,862	0.01	99.99
16	New York	779,272	25,875,480	1.47	89.01	41	Washington	2,117	39,183		
17	Alabama	2,055,929	25,451,278	1.45	90.46	42	Arizona	1,818	34,746		
18	Arkansas	1,208,310	24,156,417	1.38	91.84	43	District of Columbia	1,032	20,750		
19	Georgia	2,538,793	23,202,018	1.32	93.16	44	Idaho	569	16,408	0.01	100.00
20	Mississippi	1,570,550	21,340,800	1.22	94.38	45	Nevada	487	12,891		
21	Maryland	664,928	15,968,533	0.91	95.29	46	Montana	197	5,649		
22	Minnesota	438,737	14,831,741	0.85	96.14	47	Wyoming				
23	West Virginia	565,785	14,090,609	0.80	96.94		Total	62,368,869	1,754,861,535		
24	South Carolina	1,303,404	11,767,099	0.67	97.61						
25	New Jersey	344,555	11,159,705	0.64	98.25						

LEGEND

I. Less than ⅛ bushel per acre of total area

II. ⅛ to 1

III. 1 to 3

IV. above 3

NOTE

The absence of color indicates a population of less than 2 to a square mile being practically an absence of settlement

MAP OF THE

UNITED STATES

SHOWING THE RELATION BETWEEN THE

PRODUCTION OF INDIAN CORN

IN BUSHELS AND THE TOTAL AREA IN ACRES

Compiled from the Returns of Agriculture at the Tenth Census.

1880.

It will be seen that a comparatively few states produce the bulk of the crop, the four states of Illinois, Iowa, Missouri, and Indiana producing upward of 52 per cent.; and a similar concentration of growth has been marked at each census enumeration, five states each time producing from 48 to 58.7 per cent., and ten states from 73 to 78 per cent. of the total production. While the yield per acre, perhaps, does not increase in the places of greatest production, nevertheless the capacity for production does increase by the continual introduction of new labor-saving methods of culture. This is illustrated by the amounts grown in the states of greatest production in the five successive decades, representing a period of forty-one years. The states which stood first at the respective periods, with their production in round millions, were, respectively: crop of 1839, Tennessee, 45,000,000 bushels; 1849, Ohio, 59,000,000 bushels; 1859, Illinois, 115,000,000 bushels; 1869, Illinois, 130,000,000 bushels; 1879, Illinois, 328,000,000 bushels. While various causes have conduced to this increased production in any one state, among which are increase of population and better transportation facilities, yet the amounts grown in these later years could not have been produced and gathered by the farming population with the means and by the methods employed in growing the crop forty years ago. This relative increase of production is mostly on those soils of the West that admit of the use of the most improved implements for the cultivation of the crop. The average yield per acre is about as large in some of the eastern states, where the cultivation is more difficult, but a given amount of human labor producing a smaller result, the crop is not grown to so great an extent. Ease of tillage, capability of planting and gathering large crops with a minimum of hand-labor, along with sufficient fertility of soil to grow fair crops, characterize all the regions of specially large production.

The following tables show the amounts produced by the ten states leading in production at each census enumeration:

TABLE LI.—INDIAN CORN CROP OF 1839 (CENSUS OF 1840).

No.	State.	Amount of crop.	Per cent. of total production.	Cumulative per cent.	No.	State.	Amount of crop.	Per cent. of total production.	Cumulative per cent.
		Bushels.					*Bushels.*		
1	Tennessee	44,986,188	12	12	6	North Carolina	23,893,703	6	54
2	Kentucky	39,847,120	11	23	7	Illinois	22,634,211	6	60
3	Virginia	34,577,120	9	32	8	Alabama	20,947,004	6	66
4	Ohio	33,668,144	9	41	9	Georgia	20,905,122	6	72
5	Indiana	28,155,887	7	48	10	Missouri	17,332,524	5	77

TABLE LII.—INDIAN CORN CROP OF 1849 (CENSUS OF 1850).

No.	State.	Amount of crop.	Per cent. of total production.	Cumulative per cent.	No.	State.	Amount of crop.	Per cent. of total production.	Cumulative per cent.
		Bushels.					*Bushels.*		
1	Ohio	59,078,095	10	10	6	Missouri	36,214,537	6	54
2	Kentucky	58,072,501	10	20	7	Virginia	35,254,310	6	60
3	Illinois	57,646,984	10	30	8	Georgia	30,080,099	5	65
4	Indiana	52,004,363	9	39	9	Alabama	28,754,048	5	70
5	Tennessee	52,276,223	9	48	10	North Carolina	27,941,051	5	75

TABLE LIII.—INDIAN CORN CROP OF 1859 (CENSUS OF 1860).

No.	State.	Amount of crop.	Per cent. of total production.	Cumulative per cent.	No.	State.	Amount of crop.	Per cent. of total production.	Cumulative per cent.
		Bushels.					*Bushels.*		
1	Illinois	115,174,777	14	14	6	Tennessee	52,089,926	6	55
2	Ohio	73,543,190	9	23	7	Iowa	42,410,080	5	60
3	Missouri	72,892,157	9	32	8	Virginia	38,310,000	5	65
4	Indiana	71,588,010	9	41	9	Alabama	33,226,282	4	69
5	Kentucky	64,043,643	8	49	10	Georgia	30,776,293	4	73

TABLE LIV.—INDIAN CORN CROP OF 1869 (CENSUS OF 1870).

No.	State.	Amount of crop.	Per cent. of total production.	Cumulative per cent.	No.	State.	Amount of crop.	Per cent. of total production.	Cumulative per cent.
		Bushels.					*Bushels.*		
1	Illinois	129,921,395	17	17	6	Kentucky	50,991,000	7	58
2	Iowa	68,935,065	9	26	7	Tennessee	41,343,614	5	63
3	Ohio	67,501,144	9	35	8	Pennsylvania	34,702,000	5	68
4	Missouri	66,034,675	9	44	9	Texas	20,554,538	3	71
5	Indiana	51,094,838	7	51	10	North Carolina	18,454,215	2	73

The tables of distribution according to square degrees of latitude and longitude show that the greatest production is between the fortieth and forty-first parallels, amounting to 354,090,335 bushels, or 20.2 per cent. of the total crop, and 961,636,335 bushels, or 54.8 per cent., between the thirty-ninth and forty-second parallels. The remaining 45.2 per cent. falls off on either side of this belt, for obvious reasons more gradually on the southern side.

The table (Table XVI, p. 11) of distribution by topographical divisions shows that the greatest production is in the "prairie region", which produces 726,635,825 bushels, or upward of 41 per cent.; and this, with the four divisions marked as the "Mississippi river belt, north", the "southwest central", the "central and the Missouri river belt", produce together nearly 1,300,000,000, or upward of 73½ per cent.

Considered by drainage basins (Table XVII, p. 12), the Mississippi basin produces 82.4 per cent. of the crop, and the Ohio 22.5 per cent.

The table of the distribution of the crop according to elevation (Table XVIII, p. 13) shows that over 54 per cent. is grown at an elevation of between 500 and 1,000 feet above the level of the sea, and 82 per cent. between 500 and 1,500 feet, only 4.4 per cent. above that, and only about an eighth of the crop is grown nearer the sea-level than 500 feet.

DISTRIBUTION ACCORDING TO CLIMATE.

The ideal climate for corn is one with a summer four and a half to seven months long, without frost, the middle portion hot both day and night, sunny skies, sufficient rains to supply the demands of a rapidly growing and luxuriant crop, falling at such intervals as to best provide sufficient moisture without ever making the soil actually wet. It is popularly believed that corn grows faster when the nights as well as the days are hot, and when the ground is as dry as it is possible to be without the leaves curling in the heat of the day.

The tables of distribution by temperature (Tables XIX, XX, and XXI, pp. 14, 15) show that but little corn grows in the warmer parts of the United States, considered as to mean annual temperature or as to summer temperature. Less grows where the annual average is above 75° than where it is below 40°, 40.8 per cent. of the entire crop grows where the mean annual temperature is between 45° and 50°, 75.9 per cent. where it is between 45° and 55°, and 87.3 per cent. where it is between 45° and 60°. As with most crops, the curve of increase and decrease is not alike on both sides of the temperature of greatest production. Below an annual temperature of 45° the production falls off very rapidly, while above 50° it falls off slowly.

The distribution of the crop according to climatic conditions depends upon certain peculiarities of climate rather than on averages of either temperature or rainfall. The mean annual temperature is of much less importance than is the summer temperature, and this, in turn, is less important even than the manner in which this summer temperature is distributed. The table of distribution according to the July temperature (Table XX, p. 14) shows that more than half of the crop, or 54.8 per cent., grows where the mean temperature of this month is between 75° and 80°, and 87.7 per cent., or a little more than seven-eighths of the whole crop, where it is between 70° and 80°. The regions where these July temperatures prevail, and where the proper distribution of rain comes, lie almost entirely on the Atlantic slope, while corn flourishes under a great range of climate, and, although very sensitive to frosts, a tropical or subtropical climate is not very well suited to its growth. There is, however, a region in southern California, notably in Los Angeles county, where, with irrigation, large crops of corn are produced, and in some places even two crops per year, the mean temperature representing a much more nearly tropical climate than exists in the Gulf states, where the crop does not flourish well.

The plant is peculiarly sensitive to frost during the whole period of its growth, late frosts in spring cutting off the young plants and early ones in the fall retarding the ripening or injuring the quality of the grain; so that exemption from frost is absolutely essential. This condition prevents the cultivation of the crop to any very great extent in regions that would be suited to it were it not for liability to frosts during its period of growth; if not every year, at least often enough to render its cultivation precarious. Hence it is the first of our cereals to disappear as an important crop as we ascend into the mountain regions.

That corn needs abundant moisture is shown by its distribution in respect to rainfall (Table XXII, p. 16). Sixty-three and four-tenths per cent. of the entire crop is grown where the annual rainfall is between 35 and 45 inches, and 86.8 per cent. where it is between 30 and 50 inches. But one-half per cent. is produced where the rainfall is less than 25 inches, and only two-tenths per cent. where it is less than 20 inches. This, in part, may be due to other reasons than the mere absence of moisture in the soil. In regions where the rainfall is slight the air is usually very dry during the growing period, and in a dry atmosphere radiation is greater, and, consequently, the days are hotter and the nights cooler than in a moist climate. Such a condition exists over most of the drier portions of the United States, and notably over all those portions where the dryness and elevation go together; and this is probably one reason why so small a proportion of the crop is produced at elevations above 2,000 feet. The cool nights of such regions are not favorable to a luxuriant growth of corn, no matter how hot and how sunny the days may be. We may have a proper mean temperature and still the crop not flourish.

The distribution of the crop according to mean annual rainfall is, however, of much less interest than distribution according to the rainfall of the growing season when an abundant supply is needed. More than 65 per cent. is

produced where the rainfall of spring and summer, the growing season, is between 20 and 25 inches, and 98.7 per cent. where it is between 15 and 30 inches (Table XXIII, p. 16). Corn needs the peculiarity of rain and sunny weather coming together. The cooler summers, less sunshine, and more wet weather (not more rainfall, however) of northern Europe furnish the reason why corn does not flourish so well in climates there with a mean annual temperature like ours, and with an amount of annual rainfall which seems at first favorable to the crop.

HISTORY OF INDIAN CORN.

That Indian corn is of American origin is now universally conceded. A few early writers have, indeed, maintained that it originated in the East, and various authorities think they have found evidence that such was the case, but modern investigations have entirely failed to confirm this in any way. On the other hand, every new discovery bearing on the question only points more strongly to the conclusion that maize was entirely unknown in the Old World before the voyage of Columbus. Dr. E. L. Sturtevant, the agricultural writer, and Mr. Pickering, the eminent botanist and antiquarian, think there are earlier allusions to its American origin than the date of Columbus. It is believed by these and others that maize is mentioned by the old Icelandic writers, who are thought to have visited the coast of eastern North America as early as 1006.

But, passing by all such conjectural accounts, almost immediately after the discovery of America by Columbus the history of maize begins with a certainty. Columbus found the natives using bread of maize (mahiz) in the West Indies (*Ferdinand Columbus*, p. 28, as cited by Pickering), and it is stated that it was among the gifts he brought back from the New World and presented to Queen Isabella.

Pickering says (*Chronological History of Plants*, page 610), on the authority of Humboldt, that the cultivation of maize was introduced into Mexico by the Toltecs in 666; that the grain was used in the religious rites of both the Mexicans and the Peruvians; that sugar was procured by them from it, as also an intoxicating drink called chicha, and quotes Oviedo and Humboldt as authority that drunkenness had already become frequent under the Aztec dynasty.

Numerous explorers have found maize ears in ancient Peruvian tombs, and it is unquestionable that the early European explorers found it in cultivation in all places suitable to its growth, from Chili, on the south, to Canada, on the north. A few of the many early notices may be cited. In *The True History of the Conquest of Mexico, by Captain Bernal Diaz del Castilo, one of the Conquerors*, written in the year 1568, translated from the original Spanish by M. Keatinge and published in London in 1800, there are frequent mentions of it. The author was on the earliest explorations into Mexico, the first of which was the "Expedition of Hernandez de Cordova", which landed on the Mexican coast early in 1517, was driven out, and, returning to Cuba, reported (page 10) the discovery of "a country where the houses were built of lime and stone, the inhabitants decently clad; that they sowed maize and possessed gold". In the year 1518 he went on "The Expedition of Juan de Grijalva", where he speaks (page 17) of being presented by the natives with "bread of maize". They traveled inland, and found maize everywhere abundant. The famous "Expedition of H. Cortes" started the same year, and we are told that he took from Cuba "stores of maize and hay" for the horses of his cavalry. The expedition reached Mexico in February of the next year (1519) and found two Spaniards there, one of them already married and with three children. They were the last of a crew wrecked on the coast eight years before. This married Jeronimo de Aguilar was doubtless the first European settler on the continent of North America. We are told (page 39) that he lived about four miles from the coast, and had been employed in "digging in the maize-fields". From that time down to this the history of the cultivation of Indian corn in Mexico is reasonably complete.

King Philip sent Hernandez, the noted naturalist, to Mexico to investigate the natural resources of the country, where he remained from 1591 to 1600, and an edition of the natural history of the country was published in Spanish in the city of Mexico in 1615. This is now one of the rarest of books, but Hernandez carried back with him seventeen volumes of drawings and manuscripts, twelve of which were burned in Spain. A Latin edition of what was left was brought out in Rome, first in folio, in 1628, and then in quarto, in 1651. The quarto edition (*Nova Plantarvm, Animalivm et Mineralivm Mexicanorvm Historia, a Francesco Hernandez*, * * * * Rome, 1651) contains pictures of Indian corn on page 242, and a long chapter "concerning *tlaolli*, or maize, and concerning the drinks and variety of cakes that are commonly prepared from it". This probably represents its cultivation and use as Hernandez found it in Mexico previous to 1600. He states that the plant is American; says that even the barbarous tribes knew it, and wonders that it has not been more largely used in southern Europe. He describes in detail many kinds of cakes that were made from it, and also drinks, both unfermented and fermented. The figures given of the plant are of ears of about ten-rowed corn, and look as if of good varieties and quality.

Maize has been found in ancient Peruvian tombs, and also under similar circumstances in Mexico, New Mexico, and Arizona. Acosta was in the New World about the middle of the sixteenth century, and wrote much regarding this native cereal. A long account from him is transferred to *Purchas, his Pilgrimes*, London, 1625, vol. III, page 953, 954, etc. In that account he says it is the great bread-plant in common use in Chili, Peru, Guatemala, New Spain, etc., and thinks it as good as wheat in strength, but that it is more heating and coarse, making more blood if eaten too freely, and causing eruptions. He says there are many varieties, some small and others large; that there are big ears of 700 grains; that they plant it by hand and do not sow it broadcast; that it requires a rich soil; yields

three hundred measures for one sown; that the stalks and leaves are used as fodder; that the grain is better for horses than barley; that the Indians boil the grain and eat it hot; that they also eat it roasted, and he speaks of how delicious this roasted corn is; that they grind the grain and make cakes; that they make it into a variety of intoxicating drinks, and so on.

Ramusio, who published a collection of voyages in 1650, 1656, and 1659, also mentions this cereal. Humboldt, who investigated the matter, tells us that among the Aztecs the goddess of agriculture bore the same relation to maize in their mythology that Ceres did to wheat in the mythology of the ancient Greeks.

Gonzales Fernandez de Oviedo, who became inspector of mines in the American colonies in 1513, published in Madrid, in 1535, his *Summario*, and began about the same time his great work, *Historia General e Natural de los Indias Occidentales*, in which he gives an account of Indian corn, and says that he had seen it cultivated in Spain as early as 1525.

It is true that in Peru one other grain-plant was sometimes cultivated, quinoa (*Chenopodium quinoa*), and it was possibly cultivated in Mexico, but not farther north, but all of the early chroniclers of this country speak of maize as the one great bread-plant of the New World. The name maize was the Haytian name, and was early adopted by Europeans. It was known as *tlaolli* by the Mexicans, and under numerous names by the other Indians of America.

The earliest figure of maize with which I am acquainted is found in the old German botany (*De Stirpivm maxime earvm qvæ in Germania nostra nascvntvr*, etc.), written by Hieronymus Bock (or, as he wrote it, Tragus, translating it into Greek, according to the custom of the time). He was the first to carefully describe German plants, and published in 1539 a folio in German at Strasburg. This edition I have never seen, but I infer that Indian corn was not described in it. In 1551 he published a new edition in German, with copious illustrations, the Latin translation of which (cited above), by David Kyber, appeared next year (1552) illustrated with the same cuts. The drawings for these cuts, designed for the edition of 1551, were by David Kandel, a young artist of Strasburg, and were made under Bock's supervision. This German edition appeared only thirty-nine years after the first voyage of Columbus, and while the events of those days were fresh in the public mind. Maize is described (page 650 of this Latin edition) with a well-executed cut of the plant at full length, the stalk bearing four ears. It is described under the name of *Türkisch-Korn* (Turkish corn), which he says was "no doubt first introduced by merchants into our land from some rich soil". He describes the plant in detail, the manner of its growth and the size of the grains; says that "when the stalks of this grain are yet green and juicy they even surpass sugar itself in sweetness"; that the grains are arranged in eight or ten rows on the cob; that they are of various colors, sometimes yellow, sometimes purple, sometimes variegated, and sometimes white; so all of these varieties must have been then known in Italy. He speaks of the method of using the grain. "This grain, which the Germans call *Welschkorn*, that is, Italian (for so they are accustomed to call all things which are foreign and hitherto unknown to our part of the world), may, of course, be rightly called *Tipha Magna;* but because we have no authority for this name from the writings of the ancients we will call it in the mean time Asiatic corn, since, indeed, in Asia they say the corn grows as large as to be equal in size to the stones of the olive," and so on. On this inference he thinks it came from Asia. This was taken by later writers as history, and the belief of the oriental origin of maize probably originated with this assumption by the author of this book. He probably mistook the allusions of Theophrastus to durra for this grain, and in the popular mind much confusion then existed as to the difference between the East and the West Indies. The name Turkish corn is still used in Germany, but is of no significance, because the name "Turkish" was given to anything and everything that was foreign or outlandish; the American fowl was called the turkey. In various parts of Europe maize was early known, and is still known, under a variety of names derived from localities. De Candolle (*Géographie Botanique Raisonnée*, page 944) gives a curious list of the names under which maize is known in various parts of Europe, as *Blé de Rome* (Roman wheat) in Loraine and Vosges, *Blé de Sicile* (Sicilian wheat) in Tuscany, while in Sicily itself it is called Indian wheat, in the Pyrenees Spanish wheat, and in Provence Barbary wheat and Guinea wheat. The Turks call it Egyptian wheat, and the Egyptians the durrha of Syria; and therefore he places no more importance to the name Turkish wheat, as indicating origin, than he does to Carolina rice or Irish potatoes. Another writer, Heynius (*Opusc. Acad.*, I, page 344, Göttingen, 1785), and some later authorities, think the name Turkish, as applied to this grain, was derived from the tassel, which resembled the plume worn by the Turks on their hats, and that the silk resembled their beard, and so on. Those curious on this part of the subject may consult De Candolle, as cited before; and there is a considerable literature further noticed by Dr. E. Louis Sturtevant in a paper on corn, published in the thirty-eighth annual report of the New York State Agricultural Society. In Gerarde's *Herbal* (*The Herball; or, Generale Historie of Plantes*), published in London, edition of 1597, page 74, there is a long description of corn, also under the name of "Turkie-corne", with numerous illustrations. Some copies of the work had the figures colored by hand, and they represent the corn of various colors—red, yellow, white, and spotted purple and white, as now. He speaks of this corn as being first brought into Spain from Asia, in the Turkish dominions, and also from America. He has a poor opinion, however, of the value of the grain, and closes his description, "and it is of hard and euil digestion, a more conuenient foode for swine than for men."

All of the early European colonists to eastern North America found it in cultivation in nearly all places adapted to it. In Young's *Chronicles of the Pilgrim Fathers* (Boston, 1844), which is a publication of the *Chronicles*


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Compiled from the Returns of Agriculture at the Tenth Census.
1880.
LEGEND
I Less than ½ bushel per acre of improved land
II ½ to 1
III 1 - 5
IV 5 - 10
V above 10
NOTE
The absence of color indicates a population of less than 2 to a square mile, being practically an absence of settlement.
BRITISH POSSESSIONS
WASHINGTON
OREGON
IDAHO
MONTANA
WYOMING
DAKOTA
NEBRASKA
NEVADA
UTAH
COLORADO
KANSAS
ARIZONA
NEW MEXICO
INDIAN TERRITORY
TEXAS
MISSOURI
ARKANSAS
ILLINOIS
WISCONSIN
TENNESSEE
KENTUCKY
PENNSYLVANIA
GEORGIA
SOUTH CAROLINA
NORTH CAROLINA
ATLANTIC OCEAN
PACIFIC OCEAN
LOWER CALIFORNIA
MEXICO
GULF OF MEXICO
PUBLIC LANDS

of the Plymouth Colony, written at the time, there are frequent allusions to it and to its cultivation by the Indians along the coast of Massachusetts. Before the Pilgrims landed for settlement, in exploring the coast they came upon cornfields and a magazine of corn stored, "which we digged up, * * * and found a great fine new basket full of very fair corn of this year, some six and thirty goodly ears of corn, some yellow and some red, and others mixed with blue, which was a very goodly sight" (page 133). Indeed, all of the records of the early colonists speak of it, and often, too, as their main dependence, although they preferred English corn (wheat), and gave their chief efforts toward cultivating it.

Governor Bradford's *History of the Plimouth Plantation* (Coll. Mass. Hist. Soc., 4th ser., III, 100), in an account of the agricultural work of the Plymouth colonists, says that on the first spring, in April, 1621, as many as were able "began to plant ther corne, in which servise Squanto (an Indian) stood them in great stead, showing them both ye manner how to set it and after how to dress and tend it". This Indian told them how to manure the crop with fish, without which it would come to nothing. Other accounts show similar facts in other settlements. Indian corn was the reliance of the early settlers, the European grains often failing them from their lack of experience with the soils and climate of the country.

In all, or nearly all of the colonies, from Massachusetts to the Carolinas, there were frequent laws passed regarding traffic with the Indians in corn. Embargoes were sometimes laid on its being carried out of the country, and in some of the colonies taxes might be paid in corn. In Connecticut there were several enactments fixing the price per bushel of this cereal in paying taxes.

I have spoken of the assumed oriental origin of Indian corn, particularly the story originating with Bock. It has also been frequently stated that corn was mentioned in certain Chinese works before the discovery of America by Columbus. Dr. E. Bretschneider, physician of the Russian legation at Pekin, published at Foochow, in 1870, a pamphlet on the *Study and Value of Chinese Botanical Works, with Notes on the History of Plants and Geographical Botany from Chinese Sources.* He had made an especial study of this subject, and says that "the Chinese knowledge of plants is as old as their medicine and their agriculture, and dates from remote antiquity. The art of healing in China is in nearly the same state in which it was forty-six centuries ago". Beginning with their earliest literature relating to plants, and particularly to those used in medicine or cultivated for use, he has made an interesting investigation. He says that the Chinese authors agree in stating that cotton was introduced into China about the ninth or tenth century from the south, and "in the same manner it can be proved from Chinese sources that maize and tobacco are not indigenous in China", and he brings to bear much learning to illustrate this, with the names under which maize is now known in that country. It is widely cultivated, and bears in each province a different name. "The names used seem to prove that maize, after having been brought into Europe, spread over Asia from the west to the east." I infer from his investigation that it was extensively grown there before it was cultivated much in Europe.

It is a curious fact that this grain, after extending to the Old World, immediately after the discovery of America, appears to have been disseminated throughout Europe as a curiosity, and not (excepting in Portugal and Spain) to have become an important plant for cultivation before the present century, whereas it spread rapidly throughout Africa and entirely across Asia to China. It is found at the present time in the East Indies among savage people, who have no history or tradition of how or when it was brought there. It appears to have been adopted by the barbarous nations of the Old World more rapidly than by the more enlightened countries of Europe. Probably this is due to the fact that it was peculiarly well adapted to the agriculture of a semi-barbarous people. Susceptible of hand cultivation, it may be planted singly and in hills, rather than in fields. The large size of its ears make its management by hand easy, and it is susceptible of earlier and more varied use for human food than any of the other cereals. Boiled and roasted in its green state it constituted an important part of the food of the American Indians, and we find that the savages of Africa and of the East Indian archipelago use it in precisely the same way to-day. Sown, the stalks are sweet enough to be used for sugar. Bock mentions that in the botanical work already cited. Pickering cites Oviedo, and also Humboldt (IV, p. 9), as saying that the Aztecs prepared sugar from corn; and in *A Voyage to California*, by M. Chappe d'Auteroche, in 1768, published in London in 1770, he speaks of the same thing. He visited the western coast of America to observe the transit of Venus, and, crossing the continent in that year, he speaks frequently of the growth of Indian corn. Page 81 he says:

> The plants of maize that bear no seed, and these are numerous here, are always extremely sweet. They are brought to market at Mexico, and the children are as fond of them as they are of sugar-canes, and, indeed, they call them canes. I have pressed some of these plants and boiled up the juice, and it actually yielded real sugar. In Mexico, when they have sowed the maize, they let it grow without any culture, and then it turns to canes and bears no fruit at all.

The sweetness of the stalks of sowed corn has been noticed by frequent early writers, and it was sown for fodder by the colonists quite early in our history.

The Colonial Records of Connecticut (vol. VI, 1717 to 1725, p. 25) make mention of a petition of one Edward Hinman, made in October, 1717, "praying liberty and commission to make molasses of Indian corn-stalks in the county of Fairfield," and the assembly granted him the monopoly for ten years, "always provided that the said Hinman make as good molasses and as cheap as comes from the West Indies."

Sirup, or "molasses", seems to have been made at numerous times and places from the stalks, but never to have amounted to much. The present manufacture of "corn sugar", or "glucose", from the grain is a modern chemical process.

As before stated, the Indians taught the white settlers to grow this crop, and from the first it became the most important cereal everywhere along the coast, and, all in all, it has probably remained so. Numerous travelers, even after the Revolutionary War, speak of it as an absolute necessity in the growing of live-stock in this country, and to the present day it has continued to be our most important cereal. It is especially suited to our climate and soil, and produces a larger product of grain or of forage, if that be the object, than any other cereal. It also produces a larger amount of fattening material for either swine or cattle, and is the cheapest source of starch, glucose, and similar products. It exists in a vast number of varieties, and the certainty of the crop is remarkable, as it has fewer diseases, fewer insect enemies, and is liable to fewer mishaps than any other grain crop. Its parts being large, its enemies are also large, and thus they are the more easily seen. These, with other considerations, tend to make the crop the most prominent one in our American agriculture, taking the place of several coarse crops of the Old World. We do not cultivate to any great extent turnips, nor sainfoin, nor spurry, nor rape, nor kohl, nor mangolds, nor swedes, nor several other crops very common in Europe, simply because Indian corn is so much better in our climate for forage and feeding.

NATURAL HISTORY OF INDIAN CORN.

Indian corn is the *Zea Mays* of botanists, and, unlike all our other cereals, has the stamens and pistils borne in separate flowers. The stamens (or male flowers) are very numerous, borne in a terminal panicle (called, in popular language, the "tassel"), each spikelet bearing two flowers. The pistils (or female flowers) are borne on an axillary spike, which develops into the ear, inclosed in a leafy sheath (the husks), from which the long, slender pistils (the "silk") protrude. Sometimes a few pistillate flowers appear with the staminate in the tassel, which develop into naked grains, or more often they form a sort of terminal ear, particularly on the suckers. More rarely a few staminate flowers occur on or near the upper end of the pistillate spikes.

The disposition of the flowers affords peculiar facilities for varieties to mix in the ear.

The normal ears are produced at the nodes, or joints, growing from the fifth to the twelfth node from the ground. On the young stalk there are usually five or more rudimentary ears, the upper one being the one that develops if the stalk produces but one ear. The next lower develops if two ears are produced, the next lower if three ears, and so on. Some varieties bear habitually but a single ear, others two or more, this difference in prolificacy being a hereditary character that may be increased or diminished by proper selection. The Dent varieties usually bear their ears higher, and the stalks are less liable to branch below. The Flint varieties produce their ears nearer the ground, usually have fewer per stalk, and the plants are more liable to branch at the very base, throwing out suckers, which often produce terminal ears of abnormal development, which sometimes are naked, that is, without husk, sometimes only four-rowed, sometimes branched, and sometimes imperfect in some other way. They are usually not well-formed ears.

Like most of the cultivated cereals, there is no wild progenitor known. All our knowledge of the species is derived from cultivated varieties, all of which doubtless constitute but a single species, although a few botanists have been inclined to divide the varieties into two—all of the ordinary varieties of corn belonging to one species, the other being that known as Rocky Mountain corn, each grain of which is enveloped in a separate husk. It is now known, however, that by cultivation this character is soon lost, and it seems most probable that all of the varieties of Indian corn have been derived through cultivation from some one ancestral species.

The species had already been so long in cultivation by the aborigines of this country when it first came to be known to Europeans that all of the principal varieties which we now know were already in existence, unless it be sweet corn, which Dr. Sturtevant thinks has originated at a comparatively late period; at least he finds no early references to it. Mexico seems to me to be more probably the original home of the species, but as yet no plant has been found growing wild there from which we may believe that corn has been derived, unless, indeed, it be the following: A German botanist, Herr Roezl, who spent some sixteen years in Mexico and botanized there somewhat extensively, informs me that he found in the state of Guerrero a *Zea* which he thinks specifically distinct from Indian corn and undescribed. The ears were very small, the grains were in two rows ("truly distichous"), the whole ear (but not each separate grain) was covered with a husk, and the grains were precisely like some of the varieties of maize, only smaller and harder. If this statement be true, and it was very positively made, it is the only wild *Zea* I know of, and the only wild plant known that we may consider as a possible progenitor of cultivated maize.

Of all our grains maize is the most variable in character; is cultivated under the most different conditions; is applied to the most varied uses; is cultivated over the widest geographical range (unless possibly barley), and is applicable to the most dissimilar conditions of agriculture. Although attaining its greatest production in a temperate climate and in a region of cold winters, it is nevertheless essentially a tropical plant, in that it requires a hot summer to mature it; yet it will grow far north and in a cold climate, so far as annual temperature is concerned, provided we have the one condition of a hot summer, including hot nights, with sufficient moisture and bright sunshine.

VARIETIES OF INDIAN CORN.

The varieties are practically numberless, even more numerous than those of wheat. Various collections number a hundred or more; that of Dr. Sturtevant more than three hundred. The varieties differ from each other vastly more than do those of any other one species of cereal, and this variation is greater in every direction. There are no winter varieties of corn, as there are of wheat, barley, oats, and rye, and none of them can bear frost; but in other respects it is the most variable of cereals. In time required for maturity some varieties require six or seven months, others only as many weeks. In height, the ordinary field varieties range from 6 to 12 feet; but there are several garden varieties of less than 3 feet. There is one that is ordinarily but 20 to 26 inches high, and I have seen perfect specimens, of normal growth, maturing and producing perfect and well-formed ears, that were but 18 inches high. On the other hand, corn was shown at the Centennial exhibition reputed to be 17 feet high. In California Cuzco corn is cited in the local agricultural press at over 19 feet high. Mr. C. L. Flint speaks of a stalk of corn in eastern Tennessee 22 feet high; travelers tell still larger stories. Morelet tells of corn in Central America from 21 to 24 feet high, and John J. Thomas tells of it in the West Indies 30 feet high. But without considering these greater specimens, varieties are in cultivation in the United States which habitually range from 3 to 16 feet, and in size of ears from 2 to 13 inches; in extreme cases, from 1½ to 16 inches in length. The number of rows on the ear varies from six (even four rows on the terminal ears) to thirty-six, forty and even more rows having been reported, but I have never seen over thirty-six. In shape the ears vary from cylindrical to conical, and even to almost globular. The grains also differ in shape. Some are long and sharp, like rice-corn; some long and not so pointed, like horse-teeth; some nearly globular, others flat; some with a dent in the end, and so on through every variety of shape. In color the varieties range through white, yellow, lemon, red, pink, orange, amber, purple, striped, spotted, and combinations of all these. In texture they vary from those that are firm and flinty and pop when roasted, like the pop-corns and flint corns, to those that are soft and starchy, like the Tuscarora. Some are smooth and shining, as with the flints; others rough and wrinkled, as with the sweet corns. They differ also in chemical composition and in respect to the number of kernels on the ear, from a very small number to more than 1,400 having been reported. They vary enormously in the size of the grains, the variety of Cuzco corn (No. 17 in Table XXIV, p. 31) having only 330 grains per pound, while the variety of pop-corn (No. 12 of the same tables and No. 145 of the analysis tables) has upward of 3,600 kernels per pound, the one averaging more than eleven times as heavy as the other.

This marvelous variety of characters illustrate the plastic nature of the species and its wonderful capacity of adaptation to different conditions of cultivation, soil, and climate, new varieties being easily formed, or old ones changed to meet new conditions. Because of this, the grain is adapted to more varied conditions of agriculture (particularly as regards methods of cultivation) than any other cereal. At the one extreme no other cereal is so well adapted to the wants of a savage or barbarous people, practicing the rudest arts of cultivation; at the other extreme no other grain is produced in such enormous quantities as this is in our western states. The fact has already been alluded to that this grain spread in cultivation faster among savage peoples than among the enlightened people of the Old World.

In answer to schedule question 77, "What varieties of corn are most cultivated?" there was practically no exact information elicited. Nearly one hundred names were returned as belonging to the varieties cultivated, more than eighty of which were returned not more than three or four times, while of the remainder the vast majority represented an indefinite class of varieties rather than of varieties themselves. Thus, simply "Dent" corn is followed by various kinds of Dent, as "Ohio Dent", "Michigan Dent," "White Dent," "Yellow Dent," "Golden Dent," "Early Dent," and in a similar way each of the general terms flint, white, and yellow are returned with some simple adjective attached, as "Yellow", "Eight-rowed Yellow," "Large Yellow," "Small Yellow," "Early Yellow," "Jersey Yellow," "Maryland Yellow," "Yellow Flint," etc.

It must not be inferred from this that the varieties in cultivation are not well defined and cannot be characterized. I merely mean that in the regions of largest cultivation the nomenclature is very indefinite. Many varieties thus indefinitely returned, as "Common Eight-rowed Yellow", "White Dent," etc., probably are well-characterized and well-defined varieties in the places whence the answers are returned. In the older states some field varieties, such as "King Philip", "Dutton," etc., are well known and well characterized, but, curiously enough, few such were returned in the answers to the special schedule questions from the greatest corn-producing states.

There are a large number of what might be called fancy varieties that are well characterized, and some of them highly specialized. To these belong the numerous pop-corns, the rice-corns, the various kinds of Tuscarora and sweet corns, and some of the highly-colored corns. Sometimes these are cultivated for fancy, but more often in small quantities for some minor use, as we see in the case of the pop-corns. Some of the garden varieties used for "green corn" are greatly improved and highly specialized, and considerable quantities are thus cultivated, particularly in market gardens, the names of which would not be returned as varieties in field cultivation.

Taken all in all, I think it highly probable that as many as 150 or 200 varieties of corn are cultivated for use in the United States, which, if their history could be traced, would be recognized as being as well defined as cultivated varieties usually are, the differences between the extreme forms, as earlier noticed, being much wider than between the varieties of any other cereal.

CULTIVATION OF INDIAN CORN.

Regarding the depth at which the ground is actually plowed for corn, in answer to schedule question 78, "How deep is the soil usually plowed for corn?" the great majority of the answers in the states producing the most of the crop were from 6 to 8 inches, some as low as 5, and a very few as high as 9. More, however, were below 5 than above 8, the former generally being from those states of thinner soils east of the prairie region. Throughout the southern states the answer is frequently returned that plowing is as shallow as 3 inches.

It is universally admitted that corn requires a deep, mellow soil for the best results; but in states of gravelly or loamy soils, where the yield is rarely high but is rather certain, and where corn follows clover, it is the custom with many excellent farmers, in planting on such sod, to plow shallow, not more than 3, 3½, or 4 inches deep, but in the after cultivation to plow the corn in summer very deep. This is an old custom with some farmers of Pennsylvania, New Jersey, and eastern New York, dating back to the days when plowing was necessarily shallow because of the poor quality of the plows. It is certain that on some soils, and in the experience of numbers of eminently successful farmers, this method is good, particularly on hilly lands, but I have never heard it advocated for the deep prairie soils of the West, nor for rich bottom lands even in the states named.

In answer to schedule question 79, "What preparation of the soil other than plowing is usually practiced?" it appears that throughout New England, the middle states, and everywhere east of the mountains the common practice is to harrow the soil until the ground is in sufficiently good order for planting, but West, particularly on the prairie soils, it is very common after harrowing to roll it before planting, and sometimes other implements are used for further smoothing. Rolling on the most of the prairie soils not only leaves the ground in better shape to the eye, but the increased firmness is an advantage.

Fertilizers are more universally applied to corn than to any other cereal in this country. The most of the crop in New England and in the middle states receives some fertilizer. On the great majority of the farms it receives the most of the barn-yard manure, and commercial fertilizers are also employed to a large extent. It is probable that in New England and the middle states at least 80 per cent. of the crop is specially manured. Passing south in the Atlantic states the proportion of the manured land diminishes. Not half of the corn ground of Virginia receives any manuring other than that dropped on it by the animals, and this is probably true of the states farther south, although more of the land is manured in Georgia than in the neighboring states. In Ohio perhaps one-third of the crop, as a whole, is manured; in some portions of the state one-half or even more, the most of this being simply barn-yard manure produced on the farm. Passing westward, the proportion of the crop that receives any manure grows less, until in the newest states, Kansas and Nebraska, scarcely any of the corn receives any manuring whatever. In Tennessee and Kentucky 10 per cent. or less, judging from the answers, receive no manuring other than that dropped by the animals themselves on the fields.

PLANTING.—In the states of largest production, particularly from Ohio westward, much of the planting is done by machine; east and south, by far the most of it by hand. Where planted by hand, from two to three acres per day per man is usually considered good work, although frequent answers go higher, and also go lower, particularly in the rougher states, where one man drops the corn and a second covers it. Everywhere in the eastern states it is customary, when planting by hand, to cover with the hoe, but other methods of covering are frequently resorted to in the mellow soils of the West. In the greater corn-producing states of the West a man, with horse and machine, plants from three to eight acres per day, the majority of answers ranging to only about twice the amount per man that is planted by hand.

Whether the hills are planted in rows both ways or but one way, custom varies exceedingly in different places, and it varies by regions more than by farms. In one neighborhood nearly every one will plant in rows both ways; in another neighborhood nearly every one will plant in rows but one way. The difference in methods is sometimes difficult to be accounted for on any plausible reason, it often appearing to be due merely to local usage. We may say that, as a whole, in the eastern and middle states by far the most of the corn is planted in hills in rows both ways, thus admitting of horse cultivation. This also is the general rule in the West. Probably three-fourths or more of the corn in the United States is grown in that way, but over large areas, particularly where the land is susceptible of very easy tillage, and where the crop is not affected by certain kinds of weeds, a considerable quantity is planted in rows but one way.

In answer to question 89, "What proportion of the seed-corn is selected in the ear by hand, and what has no especial preparation?" we find that throughout most of the states seed-corn is so selected. It is to be remembered, however, that these special schedules went more especially into the hands of the better farmers; yet in each of the greater corn-growing states this is believed to be almost the universal practice, numerous answers being that it was all so selected. Usually the seed is planted dry, without other preparation; occasionally it is soaked merely in water to hasten germination; and more rarely some preparation is applied to prevent ravages by birds or insects.

The time of planting varies with the locality. It must be deferred, however, until after danger from frost has ceased. Dr. Sturtevant, a writer and experimenter on corn in Massachusetts, plants when the soil at the depth of one inch is warmed to the temperature of 50° F. The most common rule observed is that derived from the Indians on the settlement of New England and the middle states, to "plant corn when the leaves of the white oak are as big as a squirrel's foot", or, as another saying states it, "as big as a squirrel's foot or a mouse's ear."


LEGEND
I Less than 1 bushel per capita.
II 1 to 5 . . .
III 5 to 15 . . .
IV 15 to 50 . . .
V 50 to 150 . . .
VI above 150 . . .
NOTE
The absence of color indicates a population of less than 2 to a square mile, being practically an absence of settlement.
MAP OF THE
UNITED STATES
SHOWING THE DISTRIBUTION OF
PRODUCTION OF INDIAN CORN
IN BUSHELS PER CAPITA OF TOTAL POPULATION
Compiled from the Returns of Agriculture at the Tenth Census.
1880.

CHANGE OF SEED.—It has been a common experience with corn that a change of seed is less often attended with an increase of crop than is the case with the other cereals. A number of cases having been brought to my attention where seed carried from east of the Appalachian mountains to some place west of them did not succeed as well as other seed carried in the opposite direction, special inquiries were directed in question 91 to see if this held as a general rule, or only represented exceptional cases, which merely happened to be so marked as to attract notice. It has been found in numerous instances that corn of some excellent variety carried from New England or eastern New York to the more fertile West was inclined to run to stalks, the quality of the grain and the yield being inferior. On the other hand, it is a very common practice, and attended with good results, to bring seed-corn from the West for planting in New York and New England. To the end of ascertaining what was the common experience question 91 was directed: "When seed is brought from another locality, is it less liable to succeed if brought from one direction, as from the East, for instance, than if brought from another direction?" A large proportion of the answers to this question have been that it does make a difference. While the most common answer is, "Native seed the best," it was very often answered "Eastern seed least". As might be expected, there was a great variety of answers. As a whole, however, and particularly in the greater corn-growing districts, if any preference was expressed, it was for carrying seed eastward rather than westward. This is a curious question, and probably has something in it. Certain garden plants, particularly gardeners' "vines" (cucumbers, squashes, and the like), are popularly reputed to flourish best when the seed is carried westward, but the varieties thus carried do not retain their excellence.

SUMMER CULTURE.—To question 94, whether both plow and cultivator are used, the common answer was that both are used, and that there were three or four plowings or treatments with the cultivator or horse-hoe, sometimes as much as six or eight, and scarcely any less than two, and more answered "four and over" than did "two or less". In answer to question 93, it is found to be a common practice, where the plow is used, to plow deep. It has been abundantly demonstrated that frequent and deep tillage during the growth of corn not only enables it to withstand drought better, but is especially conducive to a good crop. This has long been observed, and some of the most eminent cultivators attribute this as much to the pruning of the roots as to the mere mellowing of the soil. It seems probable that both causes are involved. The well-known experiments of Dr. Sturtevant on the root-pruning of corn and the increase of the crop are especially instructive in this connection. Where corn is plowed more than once in the greater corn-growing states it is common to plow the first time not more than 3 inches deep, and the second time from 4 to 8 inches.

Regarding the tillage of corn during the summer custom varies. The plow, the cultivator, the horse-hoe, the small harrow, and numerous tools are used, some preferring what is called level culture, in which the hills are not much raised, others preferring that the corn be hilled up; indeed, this custom, originally derived from the Indians, is still the most common one. But however varied the details, the value of deep tillage to guard against drought is universally recognized.

In answer to question 95, "What proportion of the crop is not hoed at all, what proportion is hoed but once, and what proportion more than once?" we may say that in New England it is practically all hoed; perhaps not 5 per cent. but receives at least one hand-hoeing, and the most of it is hoed twice. Passing southward, in the Atlantic states hoeing becomes less and less general; it is less frequent in Pennsylvania and New Jersey than in New England, and still less farther south.

The same is true passing westward from New England. In New York the most of the crop is hoed once, some of it twice, and only a very small proportion not at all. In Ohio a little is hoed twice, but over considerable districts the most of it is hoed once; in other districts a little of it is hoed once, but the most of it not at all, the practice depending upon the character of the soil and the prevailing weeds. Passing still farther West, hand-tillage decreases, until in the greater corn-producing districts west of Ohio there is no hand-hoeing at all, unless required because of weeds. Over the most of the prairie regions, where the weeds are not particularly troublesome, there is no hoeing, and the exemption from weeds is, in a measure, related to the newness of the country. The most troublesome weeds are usually imported ones, and their introduction in any new region may be long deferred. Some of the species are troublesome because of the pertinacity with which they resist destruction, and their spread in any district is usually gradual. Once in, and once troublesome, they are never again entirely exterminated, but they remain in spite of all war waged against them, and the extent of the damage they cause is inversely as is the care taken for their suppression. Hence, in many districts where one or more species are specially troublesome, hand-hoeing, at first unnecessary, ultimately becomes an absolute necessity.

Regarding the kinds of weeds, there is so much confusion in the use of names, and the weeds themselves vary so greatly in different localities, that no rule can be given. In one place it is this, and in another place it is that, which is most troublesome, each region having its pet nuisance in this respect.

In regard to the height when mature, over the greater corn regions that most often mentioned is 7 to 9 feet, but in particular cases it is more, some answers from Kansas and the western states going as high as 12 to 14 feet, and 9 to 14 in Kansas, Kentucky, Tennessee, Missouri, and other states. The tallest corn reported in field crop is from San Diego county and Los Angeles county, California, where it is said to be from 10 to 18 feet in height.

In answer to question 98, "What proportion of corn is topped, that is, the stalk cut above the ears, before it is ripe?" we may say that in the principal corn-growing states scarcely any of it is so treated, particularly in the West. This custom, formerly very common, has fallen almost entirely into disuse, even in those states where once it was the usual practice.

HARVESTING.—Regarding harvesting a variety of methods prevail. In some places the corn is cut up, placed in conical shocks or stooks to cure, and husked afterward; in others it is allowed to stand until fully ripe and husked on the hills; and sometimes it is not husked at all, but live-stock (particularly swine) is turned in and allowed to harvest the crop for themselves. The first method of cutting up before husking is almost universal throughout New England and the middle states, and to a very great extent in all of the corn-growing states, but more particularly north. In Ohio, in Michigan, in Minnesota, and the more northern range, it generally does not cure well unless so treated. Furthermore, more use can be made of the stalks. In southern Illinois, Kentucky, Tennessee, Georgia, and that belt of states, a large proportion, if husked at all, is husked on the hill, and the stalks, or stover, allowed to stand. The third method is so wasteful that, while it is easiest, it is falling into disuse more and more each year. Still, there are considerable quantities of corn, particularly in the states south of the Ohio river, that are not husked, but cattle or swine are turned into the standing grain to fatten.

When corn is husked from the stout or from the hill 30 bushels is a good day's work, all the way from 20 to 60 bushels being noted, the larger day's work occurring, of course, in those regions where very large-eared varieties are commonly grown. As yet no satisfactory process for husking by machine has been devised. Numerous machines and appliances have been devised, but, so far as we can see from answers to the schedules, their use is too limited to amount to anything. Various appliances, like special mittens or claws to tear the husks apart more easily, are used, but except these we may say that husking-machines are not used at all. There was not a single answer received of the whole number showing the satisfactory use of any form of husking-machine. The nearest that would come was the occasional answer, "used very little," or "used very little, but not liked". A truly satisfactory husking-machine is as yet a desideratum.

Corn is easily and rapidly shelled. There are numerous shellers devised, from the cheap and simple hand-machines to large ones driven by horse- or steam-power, which shell and clean with great rapidity. The Patent Office shows that 369 patents have been issued for corn-shellers and their improvements.

PRODUCTION OF INDIAN CORN IN THE DIFFERENT REGIONS.

Corn is by far the most important cereal grown in New England. Although in bushels the amount is less than that of oats, the aggregate being for the six New England states about 7,000,000 bushels, the average yield per acre in these states is larger than in several of the more important corn-growing states of the West, and despite western competition its cultivation is maintained. While the amount grown in New England is insignificant compared with the enormous amount grown farther West, it is nevertheless an important item in New England agriculture, because of the importance of the crop both as a grain crop and as a forage crop. The stover (the corn-stalks and husks left after husking) is closely consumed by the cattle during the winter, and large quantities are grown for soiling and for corn-fodder. The varieties usually grown are Flint, which are smaller and earlier than the western. It is planted closer and much more carefully tended, nearly the whole of it being subjected to more or less hand cultivation during its growth. Some of it is hoed but once, but most of it twice. Except that it is more generally manured and has more care, there is little else to mark its culture in this section as different from that of the more important corn-producing regions.

In the middle states also the Flint varieties are mostly cultivated, and the yield per acre is, as a whole, large. The crop is, for obvious reasons, of more importance in these states than in New England, although the aggregate amount is small compared with that of the regions farther West, and the refuse stalks play a more important part for winter forage than they do West.

Both in New England and in the middle states a large amount of corn is grown for use as green or boiling corn. Much of it being grown in market gardens, and under special cultivation for local markets, the aggregate must amount to millions of bushels. There are also very extensive canning establishments in these sections of the country, where this material is canned in enormous quantities.

The great corn region of the country, *par excellence*, is in the Mississippi basin, especially that portion lying between Ohio and the plains and north of Tennessee. Six states here produce over 100,000,000 bushels each, and the yield averages above 35 bushels per acre, while the average yield of the rest of the country falls below 25 bushels. Over most of this region the climate is peculiarly adapted to the crop, and the soil is of great fertility and of easy tillage—the latter quality being a most important factor. The average yield is but little, if any, greater in ordinary years than in some of the middle and eastern states, but the ease of tillage is an immense advantage.

Over the most of this region the ground is generally plowed from 5 to 9 inches deep. A vastly larger proportion of the crop is sown by machine than in the other parts of the country, and the after cultivation is almost entirely by animal power, the most of it receiving no hoeing further than is necessary for the destruction of weeds. Over the whole of this region the different varieties of Dent corn are more commonly cultivated, all of

which grow taller and higher, producing more ears per stalk than the Flint varieties, and consequently the rows are usually planted farther apart, the distance being usually 3½ to 4 feet apart, 3½ feet being the most commonly reported distance, but occasionally it as much as 4½ feet.

The growing of corn in California presents several features quite unlike that in the other states. The most of the corn raised in this state is in the southern part, where it grows to enormous size, and where, under certain circumstances, two crops per year are sometimes produced. In most places it is grown by irrigation, but in a portion of Los Angeles county, particularly in the region known as the "Gospel Swamp", large crops are grown without irrigation. One sees in southern California what, so far as I know, he sees nowhere else in the United States—corn in nearly every stage of growth at the same time, from the young plant, scarcely up or less than a finger-length high, through to others knee high, others just coming in tassel, others fit to boil, and still others ripe.

Corn is but sparingly grown in other parts of California; it needs showers during the warmer season, and in places where the days are hot enough the nights are too cool.

Throughout the South corn is the most important cereal. West of the Appalachian mountains, notably in Kentucky, Tennessee, and portions of Alabama and Mississippi, the crop grows very heavy, the yield is often very large, and the corn of most excellent quality. The growing of corn has relatively decreased in Kentucky and Tennessee since it has become so easy to get it from Indiana, Ohio, and Illinois, whose soils do not grow so good tobacco. Therefore, where the tobacco crops increase the corn crops decrease. Corn is not so generally manured in the South as in the North, but a larger proportion is manured in Georgia than in any other southern state, judging from the answers to the special schedule questions.

YIELD OF INDIAN CORN.

In answer to schedule question 75, "What is considered a fair and what a good yield in your locality?" in all of the great corn-growing states, those which produce four-fifths of the entire crop, the usual answers ranged between 30 and 50 bushels, only occasionally running below 30 bushels, while some answers ranged as high as 75 bushels. The average of what was considered "a fair yield" in all of the great corn-growing states is considerably above the average yield as shown by the census returns, which is about 28 bushels. A "good yield" was generally placed at from 15 to 30 bushels higher than the "fair yield".

In answer to schedule question 76, "What was the largest yield per acre in 1879 in your locality?" answers were more specific. In all of the great corn-growing states there were but few regions which answered below 50 bushels per acre. Of the eleven states which together produce about four-fifths of the whole crop, seven of them reported 100 bushels and over, two of them 125 bushels, and all of the eleven reported above 75 bushels, 70 and 80 bushels per acre being not at all uncommon yields in those states. There are many accounts to be found in the agricultural literature of the country of 100 bushels per acre in many of the states.

WEIGHTS AND MEASURES USED FOR INDIAN CORN.

Corn is more largely sold by measure than other grains. In the eastern and middle states it is almost entirely moved and sold shelled, but in the West large transactions are carried on of corn in the ear. It is believed, and it is probably true, that it is less liable to heat and to sustain other damage; that it keeps better. It has been shipped to Europe in the ear because of this belief.

When sold by weight and in the ear a variety of customs prevail, as there is a very great difference in the different varieties of corn as to the relative proportion of cob to shelled corn. Because of this there is often great looseness in estimates of yields and of the quantities of shelled corn supposed to be equivalent to a certain measured amount or weighed amount of corn in the ear. For example, take a specific case known to me where Flint and Dent corn were planted on the same farm. At husking the quantities of each were measured, and the Dent variety from such measurement was estimated to yield 80 bushels of shelled corn per acre and the Flint variety 60 bushels; but when, after curing, the shelled grain was weighed when marketed, it was found that the yield of Flint exceeded that of the Dent.

Respecting the amount of shelled corn per measured bushel of ears there are numerous and varied statements found in the agricultural newspapers, but I know of no careful determinations made on any considerable quantities of ears as marketed and of different varieties for comparison. It is well known that in this respect the varieties differ enormously among themselves, and that the same variety differs in dryness at different harvests, and this affects the bulk as well as the weight.

The legal weight of shelled corn in nearly all of the states is 56 pounds; California, 52 pounds; North Carolina, 54 pounds; and New York, 58 pounds, being the exceptions. A few states have also a statute relative to the weight of corn in the ear. In Georgia, Illinois, Iowa, and Michigan the weight established by law is 70 pounds; in Indiana 68, and in Rhode Island 56, the latter probably a clerical error in the bill, meaning shelled corn, as that state has no statute weight for shelled corn. Establishments buying corn for manufacture, as of starch, whisky, or alcohol, frequently have rules of their own. Certain large establishments in Cincinnati and other cities buy corn in the ear at the rate of 78 pounds per bushel of ears. If this is bought at the ruling market price of shelled

corn, it is easy to see from the subjoined tables that a considerable profit accrues to the buyer by this arrangement. By the least percentage of corn to cob in the subjoined tables this weight of corn in the ear would yield about 62½ pounds of shelled corn.

The quantities in the following table are calculated from the determinations made in the Connecticut Agricultural Experiment Station (*Ann. Rep. Conn. Agr. Exp. St.* for 1878, page 73), and are used because they are carefully made and represent the samples analyzed and quoted in the tables of chemical composition under their respective varieties. The weighings were made in each case on but two ears. The quantities used are too small. The ears in most cases were fairer than the average crops would probably be and drier than corn in the ear ordinarily is sold, but the determinations have nevertheless a value, as showing how unlike the proportion is and what different quantities of shelled corn the same yield in ears may produce. The range varies from 3.5 to 8.4 times as much corn as cob. The average of these is about 1 of cob to 5 of corn. The legal weights in those states where established by law is about 1 to 4:

TABLE LV.—RELATIVE PROPORTION OF SHELLED CORN AND COB IN CORN IN THE EAR.

Variety.	Per cent. of corn.	Per cent. of cob.	Corn to one of cob.	Corn in the ear to 56 pounds shelled corn.	Variety.	Per cent. of corn.	Per cent. of cob.	Corn to one of cob.	Corn in the ear to 56 pounds shelled corn.
				Pounds.					*Pounds.*
Tuscarora	77.8	22.2	3.5	72.0	Coe's Prolific	83.7	16.3	5.1	60.9
Vermont White Cap	89.4	10.6	8.4	62.6	Old Fashioned Yellow	83.2	16.8	4.9	67.3
Rowley	82.2	17.8	4.6	68.1	Benton	85.8	14.2	6.0	65.3
Norfolk White	78.9	21.1	3.7	71.0	Mammoth Sweet	78.5	21.5	3.7	71.3
Canada Yellow	84.3	15.1	5.6	66.0	Scioto	86.0	13.1	6.6	64.4
Ohio White	80.8	19.2	4.2	69.3	Legal weight in Illinois, etc	80.0	20.0	4.0	70.0
Wisconsin (Dent)	84.8	15.2	5.6	66.0					

CHEMICAL COMPOSITION OF INDIAN CORN.

In chemical composition Indian corn varies more than wheat, as might be expected from the vast number and great difference of its varieties. As a whole, it is not quite so rich in albuminoids, the average of all of our analyses of wheat giving 11.84 per cent. of albuminoids; of corn, 10.82. The richest corns are about as rich as the richest wheats in nutriment; the poorer corns, however, are poorer than the poorer wheats. They vary also much more in the amount of fiber or bran, but the composition of the fiber is probably somewhat different from that of wheat. The average proportion of starch is about 2 per cent. less than in wheat, but the most noticeable difference is in the amount of oil. Corn is fattening for several reasons, because of the amount and character of its carbhydrates, and because of the fat existing, ready formed, in the grain. In wheat the fats range from 1.26 to 2.67 per cent., while in corn they range from 3.40 to 9.31 per cent., the average being 5.29. The extreme range of chemical composition is better seen by reference to Table XXV, pp. 37, 40.

Many popular errors have been repeated over and over regarding the chemical composition of corn. While there are considerable differences in the composition of different varieties, it is certain that some of the popular ideas are erroneous. The analyses lead to the following conclusions, some of which are given in the language of Professor Johnson (*Rep. Conn. Agr. Exp. St.* for 1879, p. 89):

First. That from the point of view of chemical composition there are, broadly speaking, two classes of Indian corn, the common and the sweet.

Second. That the average composition of these two kinds, calculated water free, is as follows:

TABLE LVI.—AVERAGE COMPOSITION OF INDIAN CORN.

Chemical composition.	Sweet, average of eleven analyses.	Common, average of fifty-two analyses.
Ash	2.1	1.7
Albuminoids	13.2	12.0
Fiber	2.3	1.9
Carbhydrates, starch, sugar, gum, etc	73.5	78.7
Fat	8.9	5.7
Total	100.0	100.0

The few additional analyses made since these generalizations were stated do not materially affect the average of the fifty-two analyses upon which these conclusions were based.

Third. Sweet corn, in all the analyses, contained more ash, more fat, and less carbhydrates than common corn. (If, as some believe, sweet corn is a comparatively modern variation, it may represent a higher and more-


LEGEND
I. Below 10 bushels per acre
II. 10 to 19 . . .
III. 19 . 28 . . .
IV. 28 . 37 . . .
above 37 . . .
Areas in white are those of light or no production.
MAP OF THE
UNITED STATES
SHOWING
THE AVERAGE YIELD OF
INDIAN CORN PER ACRE
Compiled from the Returns of Agriculture at the Tenth Census.
1880.
BRITISH POSSESSIONS
MONTANA
DAKOTA
WYOMING
NEBRASKA
COLORADO
UTAH
NEVADA
ARIZONA
NEW MEXICO
INDIAN TERRITORY
TEXAS
KANSAS
MINNESOTA
WISCONSIN
ILLINOIS
MISSOURI
TENNESSEE
ARKANSAS
MISSISSIPPI
LOUISIANA
GEORGIA
SOUTH CAROLINA
NORTH CAROLINA
MEXICO
PACIFIC OCEAN
ATLANTIC OCEAN
GULF OF MEXICO
LAKE SUPERIOR
LAKE MICHIGAN
LAKE ERIE
LAKE ONTARIO

Scale

specialized type.) The greater richness of sweet corn in albuminoids and fat is very decided, and indicates a higher nutritive value than common corn. Sweet corn contained on the average 2 per cent. less water, but, as already stated, it is possible that the samples had been more thoroughly dried before they came into the hands of the chemists.

Fourth. Flint and Dent corn have essentially the same composition, as will be seen from the comparison of forty-eight analyses of Flint corn and twenty-six of Dent corn:

TABLE LVII.—AVERAGE COMPOSITION OF FLINT AND DENT CORN.

Chemical composition.	Flint.	Dent.
Ash	1.7	1.7
Albuminoids	12.1	11.8
Fiber	1.7	2.0
Carbhydrates	78.7	79.0
Fat	5.8	5.5
Total	100.0	100.0

The average amount of water in Dent corn is about one-half per cent. greater than in Flint corn.

Fifth. Western corn has, in the gross average, about the same nutritive value as eastern corn. A comparison of the eastern and western samples runs very closely together. So far as we know, there is no marked difference in chemical composition between southern and northern corn. The analyses thus far made are comparatively few of southern corn, but they do not show that they are especially richer in albuminoids. They are, however, as they come to market, more sound, and in the starch factories of Cincinnati a few cents per bushel more is paid for Kentucky than for Illinois corn, and I believe the same is true in distilleries.

Much of the corn grown west of Ohio is imperfectly sheltered after husking, and before coming to market deteriorates from exposure to the weather.

Some of the characters which give value to the grain which have been assumed to be due to chemical composition are probably due to mechanical structure. Thus, it is often assumed that southern corn is richer in albuminoids than northern, and hence makes better bread; others say it is richer in starch, as shown in the manufacture of starch, etc. Chemical analyses have not thus far borne out either of these assertions, and yet the economical facts may exist as claimed. Several starch manufacturers have informed me that more starch can be made from corn grown south of the Ohio river, in Kentucky and Tennessee, than from that grown north, in Illinois and Indiana. Some consider this due to the difference of chemical composition, but others to the fact that it comes to the market sounder and drier, that there is less of it that is not entirely ripe, and that it is harder. A difference of texture may also explain its making better bread, if, indeed, this common southern belief be founded on fact, as it probably is.

We have another popular error in the explanation of corn "popping". We are all familiar with the fact that when the hard, flinty varieties are roasted the grains burst or "pop", while the softer varieties roast without popping. In a learned article published many years ago, and based on imperfect microscopical examinations of corn, the explanation given was that the flinty varieties were richer in certain essential oils, which were contained in minute six-sided cells just beneath the bran; that on roasting, when the temperature reached a certain point the essential oil was suddenly decomposed and volatilized, tearing open the grain, rolling back the fractured crust, and exposing the starch, and that the delicious aroma of freshly-parched corn was caused by the products of this decomposition.

This plausible explanation, which has done faithful service in popular writings about corn for nearly forty years, appears to have originated in imaginative deduction from imperfect observation. As our chemical knowledge of parched corn was deficient, I had three series of analyses made, each of a corn before and after parching. The analyses Nos. 178, 179 (Table XXV, p. 38) is of a pop-corn from New York; Nos. 145, 146, p. 37, another variety of pop-corn from Connecticut, this one very old and dry and popping particularly well; and Nos. 154, 155 (pp. 37, 38), a hard Flint corn from Massachusetts. Of the first two almost every grain popped on parching, and a large proportion of the third, perhaps four-fifths or more. Analyses of the raw corn showed that they were not exceptionally rich in oils, and of the parched corn that there was no loss of this ingredient in "popping", but rather a slight gain, due, perhaps, to oxydation. These vegetable oils probably absorbed oxygen, as many others are known to do.

The "popping" is apparently due to the bursting of the starch-grains. Only the flinty varieties "pop". These are more compact in structure, and as the starch-grains expand with the heat the hard exterior is burst. The aroma is doubtless due to the decomposition of some of the products in the corn, but not necessarily of an essential oil.

Roasted or parched corn is used by Indians and others who lack milling facilities, and in some forms is a very nutritious and sustaining article of food. A common kind of "panoli" among the Mexicans is made by coarsely grinding parched corn in a hand-mill, or by the Indians on a "*metata*", or grinding-stone. The coarse meal is carried dry on journeys, and used by stirring into water, or milk if it can be had, with the addition of sugar, if that

is available. It is cooling, refreshing, and eminently nutritious. Any one who has used it on a desert journey can testify to its refreshing character. It is generally conceded that, whether fed to man or to beast, parched corn is less fattening than the unparched, while equally strengthening, and its use for feeding fighting cocks is founded on this belief.

Several food preparations of parched corn have appeared on the market in recent years, some of which are very palatable indeed; and I think it eminently probable that preparations of this class will increase in popularity among those seeking novelties and variety in simple, nutritious, and palatable foods.

There is needed a careful and extended investigation of the albuminoids of corn. They are, unlike the gluten of wheat, apparently not so easily digestible with most persons, and it is more difficult to make a light corn-bread; but in skillful hands light bread is made from corn easier than from any other cereal, except wheat and rye.

Intimately connected with the bread-making qualities is the process of milling corn. There is more difference of opinion among practical millers as to how to grind corn to produce the best meal than exists regarding wheat. Some of the most successful millers say that heating during grinding affects it more than it does wheat flour, and hence that mills grinding slowly and rather "high" produce the best meal for bread, and they attribute the superior quality of the meal from certain custom mills in the southern states to the method of grinding rather than to a difference in the original grain.

The preparation of "samp" and "hominy" belongs also to milling rather than to production, and need not be discussed here.

In this connection it is well to state that although Flint and Dent corns are essentially the same in chemical composition, it is a belief among feeders that there is more waste in feeding Flint corn whole than in feeding Dent; that it is harder, not so easily chewed by the animals, and therefore less completely digested. Hence, feeders grind Flint for feeding more than they do the Dent or softer varieties, although it is universally recognized that ground corn is much more completely utilized in the animal economy.

"Green corn."—Indian corn is the only cereal used to any considerable extent for human food in an unripe state. When in the "milk" it is a most nutritious and excellent food. Its use, when green, was common among all the Indians who cultivated it when first known to the whites, and among many of the tribes its season was celebrated with feasts and religious ceremonies. The rapid spread of this plant among the savages of Africa and other parts of the eastern hemisphere was doubtless, in part, due to this peculiarly useful character. Savages usually prepare it by roasting, this method being best suited to the open fire and unconventional meals of wigwam life, and to most tastes this is the most delicious method of preparation; but civilized people more commonly boil it, which method is better adapted to the facilities of the civilized kitchen. What is lost in excellence of flavor in this kind of preparation is compensated for by its neater appearance on the table. Curiously enough, the use of green corn is still uncommon in Europe; but in America, from the earliest settlement, it has been an important item of food in its season, and many varieties have been especially improved for this use. This is the reason of the great improvement and multiplication of varieties of sweet corn.

It is not only a palatable food, but very nutritious. The chemical analyses of green corn (Nos. 219 and 220, p. 39) show respectively 14.5 and 15.3 per cent. albuminoids (the most nutritious and most costly element of human food), an amount equal to that in the very best wheat flour. Analysis No. 220 gives its composition when in the best state for boiling, showing that it is richer in both albuminoids and ash than ripe corn, these substances relatively decreasing as the grain matures, because the starch, sugar, and fat increase faster than the albuminoids do.

The preference of sweet corn for "green corn" is not merely a matter of taste; it is more nutritious, as well as more palatable, than the other varieties.

The business of canning green corn (sweet corn being used) has become one of great magnitude, single establishments planting several thousand acres annually, and the business is steadily on the increase.

Corn-fodder.—When corn is sown or planted closely a very large amount of growth is produced per acre, but the stalks do not produce grain to any considerable amount, and there appears to be a larger production of sugar in the stalk. No other crop produced in this country yields so large an amount of forage per acre, sorghum possibly excepted. There are various ways in which corn-fodder is produced and used. In the first place, the ordinary corn-stalks (in New England the term "stover" is applied to the stalks, husks, and leaves left after the corn is husked; in the middle and western states these are usually simply called corn-stalks, and in that sense the term "stalks" is used here) are nutritious, and contain a sensible amount of sugar. The experiments of Professor Collier, of the Agricultural Department, on the sugar of corn-stalks are now sufficiently well known, and every farmer who uses them knows that they contain much nutriment, and that the stalks themselves are less constipating than hay. Many farmers of the eastern and middle states preserve them carefully and feed them out through the winter along with hay, believing that they counteract the constipating influences of straw and other dry fodder.

Corn-fodder is produced in several different ways. Not unfrequently the grain is grown in hills or drills, as if for the grain, but is cut up green and is used for soiling. In this way an immense amount of very nutritious green forage may be produced per acre if needed in this form, and still be available as a grain crop if not so used. Corn-stalks, fresh, contain from 80 to 92 per cent. of water, but this is no more than ordinary succulent grasses contain. The percentage of albuminoids found in the dried material, as shown by analyses Nos. 366 to 379 inclusive, show that this is as nutritious as the poorer sorts of grain. The amount of albuminoids and fat found in the fresh

green fodder, but calculated dry, is 8.6 per cent. (*An. Rep. of the Conn. Agr. Exp. Station for* 1879, tables, page 148). It is less than it is in clover, but is as much as in many kinds of hay, and in every way the actual nutrition of this kind of fodder is very great indeed when we consider the amount that may be produced per acre.

The most common method when the crop is specially grown for "corn-fodder" and not for grain, and the one most widely applicable, is simply to sow the seed broadcast or plant in drills, cultivate while growing, cut when nearly ripe, bind into sheaves for convenience, carefully dry and store. The modern method of ensilage is now under trial. Many silos have been built within the past three or four years, and high hopes are entertained of the practicability of the method. So far as yet tested cattle thrive well on it, and the amount of forage produced is enormous. We have appended all of the analyses (Nos. 380 to 390 inclusive, p. 45) that have yet appeared, and every one of them shows a nutritive food. The physiological effects of this kind of food on cattle, if the feeding is long continued, is to be proved by longer use than we have yet had, but the promise seems certainly very great.

Regarding the amount of fodder produced by sowed corn, or corn planted in drills or in hills for the purposes of forage, there are a great many loose statements of enormous yields, founded on mere estimates, to be found in the various agricultural journals. Where careful experiments have been conducted, however, the amount is often very large. The crop represented by analyses Nos. 366 to 369, estimated from the weight of a few hills, ran from 55,800 to 80,400 pounds per acre, weighed fresh, as cut, equivalent in dried fodder to from 4,300 to 7,700 pounds. The crop represented by analysis No. 373 yielded 54,723 pounds per acre fresh (4.8 tons as field-cured), and that represented by No. 374 was 51,074 pounds fresh (5.2 tons as field-cured). In southern Germany and Austria, where experiments have been made on the yields of fresh-made fodder and the amount of dried forage (or "maize hay", as it is there called) made from it, the amounts reported in four instances average 53,440 pounds per acre. One of the largest, 64,130 pounds per acre fresh, made 12,470 pounds of the cured fodder. The enormous amount of water in the fresh crop (15 or 20 tons per acre, according to the above estimates) makes the handling of the fresh material arduous.

The cured fodder also contains a very considerable percentage of water. The analyses (Nos. 375 to 379) of the field-cured fodder show the amount to be from 27 to 36.5 per cent., which is enormously large as compared with other straw, hay, or field-cured forage. The hygroscopic character of this is truly remarkable. The crop from which the samples were taken for analyses Nos. 373, 374, 376, and 377 was grown in southern Connecticut in 1874. The corn, on cutting up, was set in the field in stooks or stouts, where it remained until November 11, when it was removed to the barn in excellent condition. The fall weather of that year was exceptionally fine and dry, and the fodder in the field became very well cured with a water content of 27 per cent., while the stover the same year contained 36 per cent. After the crops were housed during the warm and damp winter of 1874 and 1875 they absorbed moisture from the air to such an extent that the average 5 tons of fodder as stored November 11 became 8 tons as it lay in the barn February 8.

Such variability in the water content of the harvested crop appears to have been nowhere else observed. In this case the fodder was not closely packed away in the barn, but, on the contrary, was stored as loosely as possible for the purpose of favoring fresh curing, and this very circumstance enabled it the more rapidly to recover water during the early rains. No other kind of forage is so absorbent of moisture as this.

For a discussion of the chemical composition, digestibility, and feeding value of corn-fodder and corn-stover, as compared with hay and various other feeding stuffs, see Professor Johnson in the *Report of the Conn. Agr. Exp. Station for* 1878, page 58; 1879, page 71; and 1880, tables, page 78.

EXPORTS OF INDIAN CORN.

Corn and corn meal have been articles of export since colonial days. The two things that have operated most against its export were the vulgar prejudice against its use among the poorer classes abroad, until of very late years, and the difficulties of shipping it in good condition. The grain, when fresh, contains a larger amount of water than other cereals. It is harvested later in the year, when it does not dry out so readily, and the kernels are larger and dry slower than other grains. It is liable to come to market containing 15 or 20 per cent. of water, and to mold, or at least to be injured on the voyage. With experience in the handling and drying, and the use of steamers for ocean freighting, this danger is largely overcome. "Steamer corn" means corn dry enough to make the voyage safely by steamer, but which would be liable to damage by the longer voyage by sail.

The full tables of exports (Tables V to XIV, pp. 4–9) show the amount and destination of exports; but the following table, which gives the totals for each ten years, shows the history of this commerce in a more striking way:

TABLE LVIII.—EXPORTS OF CORN AND CORN MEAL SINCE 1790.

Aggregate ten years' export.	Corn.	Corn meal.	Total value.	Aggregate ten years' export.	Corn.	Corn meal.	Total value.
	Bushels.	*Barrels.*			*Bushels.*	*Barrels.*	
1790 to 1799	14, 812, 565	824, 967		1840 to 1849	41, 275, 449	3, 573, 170	$41, 445, 507
1800 to 1809	12, 430, 044	1, 202, 037		1850 to 1859	54, 784, 029	2, 438, 531	47, 907, 634
1810 to 1819	12, 490, 801	933, 484		1860 to 1869	102, 527, 365	2, 578, 247	95, 804, 532
1820 to 1829	7, 134, 604	1, 545, 820	$8, 722, 040	1870 to 1879	439, 656, 035	3, 422, 376	281, 926, 383
1830 to 1839	3, 621, 747	1, 000, 551	8, 483, 710	1880	98, 169, 877	350, 711	54, 279, 608

USE OF INDIAN CORN IN MANUFACTURES.

With the advance in chemical knowledge the cereals are becoming more and more the raw material used in various manufactures. Down to very recently the uses of cereals were practically but three: food for man, food for his domestic animals, and the source from which fermented and distilled liquors and alcohol were derived. In this country corn has taken the place of all the others as a raw material in manufactures where only starch or its derivatives are necessary. It is the source of nearly all the distilled liquors and alcohol produced in the country. Alcohol and the alcoholic liquors of commerce are the immediate result of products produced by the fermentation of some kind of sugar or of analogous substances derived from starch. Corn is the cheapest source we have of starch, and consequently of all of its derivatives. Hence it is the source of most of the distilled liquors and of all of the alcohols produced in this country. Rum from native molasses is produced in comparatively insignificant quantities, and the amount of distilled liquors from the fermented juice of fruit is also small compared with the production of whiskies from corn. Whisky may be produced from any cereal, and formerly much rye and wheat were used. Before the days of cheap railroad transportation, in regions distant from market this was the most concentrated product into which grain could be transformed, and then particular localities produced large quantities of whisky from wheat and rye. The so-called Monongahela whiskies of western Pennsylvania are famous examples. But of late years, since railroads have equalized prices, corn has come to be almost the only source of either alcohol or whisky, other grains being used only for a few especial brands manufactured here and there, or, where damaged grain is used, for producing alcohol or an inferior article of whisky. It is probable that a change in public taste has also had something to do with this, as it is certain that rye whisky is less popular than formerly.

Aside from the enormous consumption of corn in the manufacture of alcohol and distilled spirits, its use is rapidly increasing as an ingredient of malt liquors, either directly, as meal, or indirectly, as glucose. How much corn is thus consumed there is at the present time no means of knowing, because much of this use is clandestine. Doubtless its use will increase and in time will be more openly recognized.

Corn is the source of nearly all of the starch manufactured in the United States. In other countries laundry starch is made from potatoes, wheat, rice, and a variety of materials, but except comparatively small quantities made from potatoes, principally in Maine, the starch of the United States is produced from corn, and some of the starch establishments are doubtless the largest in the world. Two processes are used, known respectively as the acid process and the alkaline process. The corn is first soaked and coarsely ground. By one process the albuminoids are brought into suitable shape for washing out by souring by fermentation; in the other by treatment with alkalies, and then, in either case, the starch is washed and dried. A considerable number of food preparations, consisting of nearly pure starch, have their basis also in corn, as corn-starch, maziana, and similar products. The aggregate amount produced is quite large, and they are taking the place, in this country at least, of the various finer forms of starch, like arrowroot, and their consumption is increasing.

I have made microscopic examinations of a large number of American starches, and found them all exceedingly pure corn-starch.

Good, sound corn in the best conducted starch factories will yield about 40 per cent. manufactured starch. If the grain is very sound and very dry it will produce more, sometimes as much as 25 pounds per bushel of corn; but, as much of the corn comes to market, its water-content is large, and the actual amount of starch produced probably averages not over 22 or 23 pounds per bushel of corn used.

The manufacture of "corn-starch sugar", "starch sugar," or "glucose" is just now attracting much attention. A Russian chemist discovered in 1811 that, by boiling with diluted sulphuric acid, starch was converted into sugar. In the state in which chemical science then was, this was believed to be the same as cane sugar. In the wars of Napoleon, when much of the continent of Europe was under blockade by the English, this was turned to account, and many starch-sugar factories came into existence, a great deal of this material being made. When, however, this blockade ceased, and it was discovered that starch sugar was quite a different substance from cane sugar—was less soluble, had less sweetness, and was but a poor substitute for it—this industry declined, although the use of the sugar for the manufacture of alcoholic liquors and beer was recommended.

From time to time there were attempts made to start the industry in this country, but they were not, as a rule, successful. The sirups were occasionally seen in market, but the manufacture, as conducted, usually soon failed. In recent times, with changes in the process of sugar-making, by which sirups and molasses became more scarce and dear, and, along with the great advances in chemical science and in the manufacturing industries dependent upon it, this business again revived, and improvements were made in the processes, the manufacture has suddenly assumed large proportions. According to a late article by Professor Wiley (*Popular Science Monthly*, June, 1881, p. 251), "On August 1, 1880, ten glucose factories were in operation in the United States, consuming daily about 20,000 bushels of corn." He gives the enumeration, with the capacity of each, but I personally know that the capacity of one or two of these factories was greatly underrated, and the total consumption of corn was probably much more than he states. The same authority says:

> At that time there were in process of construction nine factories, with a total capacity of 22,000 bushels per day. * * * We may safely assume that at the present time (May, 1881) one-half of the new factories are in running order, and that the total consumption of corn for sugar and sirup-making is not far from 35,000 bushels, * * * and 11,000,000 bushels of corn during the present year (1881) will be used for this purpose, every indication leading us to believe that the amount will be doubled in 1882.

The development of this industry is an interesting phase of applied chemistry. It is generally associated with starch-making, that the product may be used as starch or turned into glucose or sirup, as the demands of the market and the nature of the corn crop may indicate as most profitable. Many patented processes are involved in the details of these various factories, some of them relating to the production of starch or glucose, others to the utilization of what would otherwise be waste material. For example, chemical analysis shows that ordinary Dent or Flint corn contains from 3½ to 7 per cent., or an average of about 5 per cent. of oil, and there are several patented processes for the saving of this oil. It is claimed that by some of these processes an average of 3 or 4 per cent. of the total weight of corn used is saved as oil. Corn-oil has been saved to some extent in distilleries, and before the days of cheap petroleum it was used for burning in lamps. I have no specific information of what its chief use now consists, but a considerable portion of it goes to England, and I am told that from there a considerable quantity goes to those portions of Africa that ship palm-oil, and this awakens a suspicion in my mind that some of it may come back to us as palm-oil soap, or, possibly, palm-oil itself.

I have already, when speaking of the history of corn, spoken of the early knowledge we had that the stalks contained a considerable quantity of sugar; that Humboldt speaks of the South American Indians making sugar; that d'Anteroche found the Mexicans growing it for the canes; that a franchise had been granted in Connecticut, and the like. This subject has lately been again brought into public notice, and Professor Collier, chemist to the Department of Agriculture, has carried on a most instructive series of observations and experiments, which leads to some hope that commercial success may ultimately attend the extraction of sugar from corn-stalks.

Corn as a raw material for the production of meat, pork, and animal products will be discussed later.

INDIAN CORN AS FUEL.

On the newer prairie farms in the far West corn in the ear is sometimes used for fuel, and this fact is frequently spoken of as if it were a sad thing that a grain should be burned for fuel when millions of people may be pinched for bread. I have taken some pains to investigate the economic aspects of this question, and it is evident that it frequently happens that this use of corn is not only not wasteful, but is an eminently practical source of fuel. That dried cobs form an excellent fuel is well known to every farmer, and the chemical composition of the grain shows that its heating qualities are also great. Corn in the ear is equal to good hard wood, and is probably equal to the very best of seasoned hard wood.

The cost of transportation is discussed elsewhere as regards grain, but the same laws will apply to the transportation of fuel. If the new settler be in a treeless region, somewhat distant from market, and has to buy his fuel and pay for it with the corn which must be hauled to market—it may be 15 or 20 miles, and his fuel brought from a similar distance—it often happens that it is cheaper to burn the corn itself than to transport it to market to buy fuel with. An acre will produce, say, 50, 80, or 100 bushels of ears. A cord, 128 cubic feet, is about 100 bushels, or less than that number as corn in the ear is usually measured, and therefore 100 bushels of ears of corn may be considered equal to or exceeding a full cord of hard wood. Many persons pay more for a cord of wood in the markets in our eastern cities than is the usual value of 100 bushels of ears of corn on such a farm, and the farmer on a distant and new prairie farm, who has to burn his corn to keep himself warm in winter, is in no worse plight, and pays no more for his fuel, if indeed as much, than the person elsewhere who has to pay $10 or $15 a cord for wood.

DISEASES AND MISHAPS OF INDIAN CORN.

Corn is less liable to damage from disease than any other cereal. So far as I know, there is no rust, blight, or mildew which attacks the vegetative portion in sufficient force to constitute a disease or sensibly affect the crop. The only disease to which it is subject is smut. This, unlike smuts of other grains, while most commonly developing within the grain (as is the case with other smuts), also develops in the vegetative portion of the plant. It is caused by the fungus *Ustilago maydis*. When it occurs in the ear, some of the grains may be smutted and some not, the smutted ones growing to an enormous size and being entirely filled with a brownish-black powder, which consists almost entirely of the spores. These, when seen under a microscope, are rough, covered with short spines, and are much larger than the spores of wheat-smut.

Regarding the way in which this disease is propagated in the field there is some difference of statement and of opinion. Plants may be inoculated artificially in the stalk or leaves and smut produced, and we sometimes see in the field a bunch of smut on the side of the stalk. It is possible that the infection has taken place in such cases from without. In some parts of the country it is the custom to treat corn with blue-stone (copper sulphate), the same as seed-wheat, for the double purpose of protecting it from smut and to prevent birds from eating the seed. I am informed that this does not entirely prevent smut, and that in such cases smutted ears often occur.

It is rare that there is sufficient smut in the corn materially to affect the crop. I have never seen a field which was injured to the extent of 1 per cent., but I have heard of cases in the year 1879 (in which year corn seemed especially liable to damage from smut) where the damage was estimated to amount to one-sixth. Many farmers believe that fields become infected; that the throwing of smutted corn on the ground at the time of husking infects the soil, and if corn is planted on the same field the next year the liability to smut is increased; and this seems to me eminently probable. The subject of corn-smut has attracted less attention than the other smuts, simply because it is less destructive. The agricultural papers indicate that it is on the increase, especially in the older states.

Discussion has gone on in the agricultural papers for many years as to whether corn-smut was poisonous to cattle when eaten. There is a great deal of testimony on both sides: on the one hand that cattle have died from eating it, and, on the other hand, numerous cases are related where cattle have eaten corn badly smutted and no ill effects were observed to follow. The balance of testimony, however, is strongly on the side that it is usually injurious, and that it sometimes produces death.

Unless protected in some way, the young plants are liable to injury from birds, but this is so easily prevented by "scare-crows" of infinite variety, or by rolling the seed in tar, or in some way rendering it unpalatable, that serious loss need not happen from this cause. In forest regions squirrels, raccoons, etc., sometimes destroy considerable quantities of the seed, but the aggregate loss from such sources is very insignificant.

A more common loss is from insects. The following memoranda of the species are furnished by Professor Riley, under whose direction the entomological matter of this report was chiefly prepared by his assistants, Messrs. B. P. Mann and L. O. Howard:

INSECTS INJURIOUS TO MAIZE.

The present memorandum is divided into two parts:

The first part gives the indications by which the ravages of the respective insects may be discovered; the second part is a brief indication of the principal remedial measures which may be adopted to lessen or prevent the ravages of these insects.

I.—Indications.

Injuring the seed and root.

The first insects to injure a crop of maize are those which feed upon the planted seed, and chief among these are the wire-worms, larvæ of different species of the family *Elateridæ*, which at maturity are known as snapping-beetles, click-beetles, skip-jacks, or by other names. It may be remarked, in passing, that none of this family of insects is known to be in any way beneficial, unless it may be in assisting to remove dead trees or promote their decay, and, in consequence, the farmer may safely destroy all of them with which he comes in contact.

The presence of wire-worms in the field is first revealed by the failure of the young plants to appear in due time after seeding, and the sown field shows many gaps, which require to be replanted. This is in consequence of the destruction of the germinating seed or of the young plants by the wire-worms.

The development of the young plant is prevented also by the "seed-corn maggot" (*Anthomyia zeæ*), which excoriates and gnaws into the seed-corn, and finally causes such seed to rot (*a*).

Injuring the young plant.

When the plants have germinated and appeared above the ground they become subject to the attacks of a number of insects, which feed upon either the root, stem, stalk, or leaves. The first indication of injury will be the wilting of the leaves.

If, upon taking hold of the leaves, it is found that they can be drawn out with the included spindle, it is probable that they have been attacked by the spindle-worm (*Achatodes zeæ*). A further indication of injury by these larvæ is the presence of a small hole in the side of the leafy stalk near the ground, which gives access to the soft center of the stalk, and this center will be found to be perforated, both upward and downward, by a slender worm-like caterpillar, whose excrementitious castings surround the orifice of the hole (*b*).

Should the young stalk, however, appear as if it had been cut off with a knife, this would point to the ravages of cut-worms (larvæ of *Agrotis* and related genera). Different species of these worms work in a different manner. Some cut off the spears of corn about an inch below the surface of the ground, in most cases severing the culm; whereas others cut off the plants half an inch or an inch above the surface of the ground (*c*), the plant being killed invariably in the former case, while in the latter it may send forth new leaves and survive.

When the stalks are cut off above the ground, they fall over naturally, thus making the locality of the ravages more conspicuous.

Similar injuries may be occasioned by wire-worms (the larvæ of *Elateridæ*), or by the "white-grub" (*Lachnosterna querana*), although the latter is more apt to attack the stems when they are more fully grown.

Should the wilted stem, however, not be severed, it may be found to be punctured near the ground and riddled with holes of about the size of ordinary pinholes, which sometimes extend below the surface of the ground. Such injury is done by the "corn-curculio" (*Sphenophorus sculptilis*) in its perfect or beetle state if in the more northern states, or by an allied species (*Sphenophorus robustus*) in the more southern states, where it is known as the "bill-bug", and where both larva and beetle work in the stalk near or just beneath the surface of the ground. If the roots are perforated by larvæ, which fill them with their burrows, the work of the *Diabrotica longicornis* is indicated. The immense larva of a *Prionus*, probably *P. imbricornis*, is sometimes found to have gnawed or to have made its way into the roots of maize plants.

Finally, the roots and the base of the culm below the ground may be found covered with aphides (*Aphis maidis*), which deprive the plant of its nourishment.

Injuring the more mature plant.

The stalk having attained a larger growth, it may be to such a point that the male and female flowers, or tassels and ears, have appeared, is subject to the attacks of yet other insects. Many of these manifest their presence openly, feeding upon the stem or leaves, or on all portions indiscriminately. Such are the chinch-bug (*Blissus leucopterus*), rose-chafer (*Macrodactylus subspinosus*), locusts (especially species of *Caloptenus*), the army-worm (*Leucania unipuncta*), the fall army-worm (*Laphygma frugiperda*), and other caterpillars, and plant-lice (*Aphididæ*). The chinch-bugs and plant-lice feed only by suction, while the others eat in the more ordinary sense of the word. The presence of plant-lice may usually be suspected if ants are seen running up and down the stem.

If the grown stalks wither, wilt, or die, and upon examination a small round hole is detected in the stalk near the ground, the ravages of the "stalk-borer" (*Gortyna nitela*) are indicated, and the larva will probably be found inclosed in the pith. There are also various other lepidopterous borers in the stalk, especially in the southern states. If, however, the stalk dies and falls over without these manifestations, it may be found that the main root has been eaten off near the top of the ground by the "white-grub" (*Lachnosterna fusca*).

a Riley, 1st Ann. Rept. Ins. Mo., 1869, p. 155.

b Harris, Ins. Inj. Veg., 1862, ed. 3, p. 438.

c Fitch, 6th–9th Repts. Ins. N. Y., 1865, p. 244; Riley, 1st Rept. Ins. Mo., 1869, p. 80.

Injuring the ear.

Finally the fruit, or ear, is attacked by "corn-worms" (larvæ of *Heliothis armigera*). These are found feeding upon the tassels, or male flowers, before the ears make their appearance; at a later season upon the silk of the ears, and still later upon the kernels at the tip of the ear, boring through the husk, or entering from the top for the purpose. The ravages of these caterpillars open the way for the attack of other insects upon the corn in the cob. The larva of the stalk-borer (*Gortyna nitela*) has also been found boring in the cob of growing corn.

Orchelimum glaberrimum sometimes deposits its eggs in the tops of corn-stalks, but does no noticeable harm.

Injuring the stored grain.

If the kernels of grain, especially after it has been stored, are found to be hollowed out by footless grubs, or small, black snout-beetles, it is probable that this is the work of the rice-weevil (*Calandra oryzæ*); if the larvæ within the kernels are 16-footed, however, they are probably those of the Angoumois moth (*Butalis cerealella*). In case of attack by either of these insects, there is a period when the insect rests in the pupa state within the grain. Its kind may then be determined by noticing its resemblance to a beetle in the one case, and to a moth in the other.

If the grains are gnawed into from the outside and connected together by a web, this is probably the work of the grain-moth (*Tinea granella*).

II.—Remedies and preventive measures.

Wire-worms, cut-worms, and white-grubs.

It seems to have been ascertained by investigations in Europe that the length of life of a wire-worm may be five years, although Dr. Fitch considers it more likely that in our climate this period is one only of two years (*a*). Hence it follows that under ordinary circumstances the ravages of these insects may be expected to continue in a given field for that length of time, even if measures are adopted to prevent the deposition of eggs from and after the beginning of that period. A satisfactory and sufficient method, therefore, of preventing the deposition of eggs would not show its full effect until after the lapse of two or five years, as the case may be.

The attempt has been made to apply some substance to the ground which would destroy the wire-worms without being injurious to the crops planted at the same time, or which would, at least, be so obnoxious to the insects as to drive them away. It is very doubtful whether any substance could be found that would accomplish the latter object, owing, if for no other reason, to the difficulty that the larvæ would find in effecting a migration. For this purpose guano has been recommended to be used (*b*). Byrkander recommended that experiments should be tried of mixing leaves of fir and certain other plants with the manure to be spread on the land, thinking, from his experiments, that the odor of these leaves would be obnoxious to the wire-worms, if not fatal to them (*c*). The eggs having been deposited, and the young wire-worms hatched, it is impossible by any change of crops to prevent their ravages, unless, indeed, some vegetable should be discovered which they absolutely dislike, and it is doubtful whether any such exists. It has been strongly recommended, however, to sow white mustard (*Sinapis alba*) (*d*), dyers' woad (*Isatis tinctoria*) (*e*), and buckwheat (*Fagopyrum esculentum*) (*f*), under the belief that these plants are distasteful to the wire-worms.

For the destruction of the wire-worms in the soil, slaked and unslaked lime, soot, and salt have been recommended, and in many cases these applications are claimed to be effectual, while in other cases they have not proved of any avail.

Hon. A. B. Dickenson, of New York, sowed 10 bushels of salt to the acre (nearly 9 liters to the hectare) upon one occasion, and 100 bushels of lime (probably slaked) to the acre (87 liters to the hectare) upon another occasion, without any benefit. Unslaked lime has also been recommended.

It is very likely that in those cases in which the application of these substances to the ground has seemed to be followed by good results the time had arrived for the natural disappearance of the insects, and that the applications were really of no effect. However, in certain soils, lime and guano, as well as many other substances, are beneficial as manure, and whatever tends to enhance the vigor of vegetation is in so far a protection against the ravages of insects. For any substance applied to the ground to be really effectual immediately in the destruction of insects it would have to be applied in such quantities, probably, as to be injurious also to the vegetation.

As a further protection to crops, the attempt has been made to protect the seed from attack by soaking it in some substance which would make it distasteful to the larvæ while not impairing its vitality. It might naturally be expected that the hunger of the larvæ would oppose a powerful obstacle to the success of this class of remedies; moreover, as the larvæ do not attack the seed alone, but the young plants as well, this remedy can be of only partial avail.

For this purpose it has been recommended to use solutions of saltpeter, chloride of lime, or copperas, or combinations of these, or to cover the seed, before planting, with a coating of tar.

The testimony in regard to the results of soaking the seed is conflicting.

It is not stated in what proportions saltpeter has been used, but it is said that the wire-worms will endure a considerable quantity of that as well as of copperas, while a little too much of either destroys the germinating power of the seed.

Mr. Cyrus Thomas quotes Mr. R. M. Graves as saying that he soaked evergreen sweet corn in a solution of 14 parts chloride of lime, 7 parts copperas, and 2,000 parts warm water for 18 hours, rolled the corn in ashes, to separate the kernels, and planted immediately in sandy soil. Four days after every kernel, except one, was found to be dead (*g*).

In few cases, and those quite inconclusive in their nature, is any good stated to result from soaking in these solutions, except in some instances the hastening of the germination of the seed. In many cases no other good result is reported to have been attained.

Coating the seed with tar may perhaps be more efficacious as a protective measure. It has the sanction of some favorable testimony, without any positive denial of its good effects. In the application of this precautionary measure care must be taken that the seed is well soaked before the tar is applied, and is so nearly at the point of germination that it will not need any accession of moisture, for the tarry coating effectually excludes all moisture.

It is recommended that the corn should be soaked in warm water for twelve hours or more, and then stirred either in clear tar or in tar and water until every kernel is completely coated with tar; after that it should be rolled in ashes, lime, or some dry powder, so as to separate the kernels, and finally planted in the same manner as dry corn. Should it appear, however, that neither the larvæ can be destroyed by applications to the land nor the seed can be protected from their attacks while they remain in the ground, it is recommended that the fields should be allowed to remain free from crops for a period long enough to enable the larvæ in the ground to complete their transformations, while measures should be adopted at the same time to prevent the deposition of eggs, which would produce their new crop of larvæ. It is a generally received opinion that the beetles will not deposit their eggs in ground which is under cultivation, choosing only undisturbed surfaces for that purpose (*h*).

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a Curtis, Farm Insects, p. 161.
b Thomas, 6th Rept. State Entom. Ill., 1877, p. 120.
c Fitch, 10th and 11th Repts. in N. Y., 1867, p. 83.
d Fitch, 10th and 11th Repts. Ins. N. Y., 1867, p. 81.
e Fitch, l. c., pp. 80–81.
f Fitch, l. c., p. 82.
g Thomas, 7th Report State Entom. Ill., 1878, p. 24.
h Curtis, Farm Insects, p. 161.

Consequently, frequent plowing, harrowing, or hoeing of the ground may be expected to prevent the deposition of eggs. If at the same time any crop can be raised which the worms will not touch, the ground may be saved from lying idle; but in order to free it from wire-worms by starvation it must be kept entirely free from weeds or plants of every kind upon which the worms will feed, especially from grasses. While there is no certainty, from the results of experiment, how long the larvæ can live without food, it is believed that they cannot live long.

It is very hazardous to resow where wire-worms have destroyed a crop unless the soil be plowed repeatedly. Nearly all writers concur in recommending the plowing of the ground frequently late in the fall as one of the most efficacious remedies against wire-worms, cut-worms, and white-grubs, as it is supposed that nearly all the species pass the winter in the ground in a torpid state, and that by plowing late enough these would be turned up while torpid, and so be unable to seek the shelter of the earth again, and would be killed by alternate freezing and thawing, by freezing under unnatural conditions, or would be found and eaten by birds. Crows, blackbirds, domestic fowls, and numerous small birds feed upon them with relish. To make this plowing more effectual, the sods should be completely broken up with the harrow. Some persons, however, doubt the efficacy of fall plowing, on the ground that the larvæ are not more likely to be frozen if plowed up than they would be in their chosen situations, and, moreover, that freezing does not kill them.

Mr. Riley suggests that in corn-fields which have been subject to the attacks of cut-worms it is well to plant so much seed as will enable the worms to glut their appetites without taking all the stalks in the hill (*a*). The same suggestion might apply to other larvæ which live and feed underground, but this cannot be looked upon as properly a remedy.

In similar way it has been recommended to break rape-cake into small fragments and spread it over the ground, to the amount of three hundred weight per acre (3.4 kilograms per hectare), and plow it in before sowing. The wire-worms are said to be more fond of this than of any other food, and will not trouble any crops of plants if they are supplied with it.

In general, most measures recommended as good against either wire-worms, cut-worms, or white-grubs underground will be equally good against all three of these classes of pests.

Corn-worms.

After the wire-worms, cut-worms, and white-grubs combined, the most formidable enemies of growing maize are the chinch-bug, the locusts (in their region), the true army-worm, the fall army-worm, and the corn-worm. All but the last of these have been treated in the section upon wheat insects.

Remedies against the corn-worm (*Heliothis armigera*) may be directed either toward securing the ears of corn against attack, toward the destruction of the chrysalis, or toward the capture and destruction of the larva or of the perfect insect.

To secure the ears of corn against attack they must be brought to maturity, or the kernels made hard before the caterpillars have attained their growth. Early planting of the seed is recommended for this purpose, so that the natural process of growth may be completed early; yet Mr. Riley says that the most injury is done to very early and very late corn (*b*). The caterpillars feed first on the tassels or male flowers, then (in the next brood) on the silk of the female flowers, and lastly on the grain while in the milky state. The occasion of great injury to very early corn may be that the first brood, which would otherwise feed only upon the tassel, finds the ears of this precocious corn in a state suitable to be attacked.

It is recommended also that the tops of the stalks should be cut off after the ears are set, this process being believed to hasten the ripening of the grain (*c*). Those caterpillars which are not full-grown before the grain becomes hard generally die undeveloped, though some instances are recorded in which they have fed upon the hard kernels of well-ripened ears (*d*).

It is believed that the chrysalis of the corn-worm may be destroyed in the fall and winter by plowing the ground, as certain experiments made by Mr. G. H. French showed that while in its natural burrow the chrysalis can endure freezing, but when the burrow is broken up, and the chrysalis is covered with damp, loose dirt, freezing is fatal to it (*e*).

As a protection against the same insect in the southern United States, where it is known as the boll-worm, and is very destructive to the boll of cotton-plants, the capture of the moths by lights and pans of kerosene is more or less successful, and the same preventive measures may be adopted in the corn-field.

Mr. Riley says that the only remedy when they infest corn is to kill them by hand. By going over a field when the ears are in silk the presence of the worms can be detected by the silk being prematurely dry, or by its being partially eaten (*b*).

Other insects.

Against the greater number of other insects infesting maize remedial measures are simple, or, if not so, hardly worthy of the attention for which they call, as these insects do little serious damage to the crop.

The stalk-borer (*Gortyna nitela*) and the spindle-worm (*Achatodes zeæ*) must be destroyed while in the caterpillar state. As soon as it is discovered that the larvæ are at work in the stalks, they should be sought for and killed. They may be cut out of the stalks, or the stalks may be cut down and given as food to cattle, care being taken that the caterpillars do not escape.

The application of lime, ashes, or guano around the roots of the plants is recommended as a means of destroying or driving away the corn-curculio (*Sphenophorus soulptilis*), the corn-maggot (*Anthomyia zeas*), and the long-horned diabrotica (*Diabrotica longicornis*). It might serve also against plant-lice on the roots.

The caterpillars generally, which feed upon the leaves or other portions of the plant exteriorly, must be captured and destroyed when seen. The same is the case with the rose-bug (*Macrodactylus subspinosus*).

Stored grain.

To preserve stored grain from the attacks of the rice-weevil (*Calandra oryzæ*) winnowing and sifting the grain and gathering and destroying the insects is recommended; also, inclosing the grain in tight vessels, and placing open dishes of bisulphide of carbon (CS_2) on the top of the piles. Great care must be taken in the use of this highly inflammable compound not to bring any fire or even spark within reach of the vapor.

Harris says it has been proved by experience that the ravages of the grain-moth (*Tinea granella*) and the Angoumois (*Butalis cerealella*) "can be effectually checked by drying the damaged grain in an oven or kiln, and that the heat of 167° F. (75° C.), continued during twelve hours, will kill the insects in all their forms. Indeed, the heat may be reduced to 104° F. (40° C.) with the same effect, but the grain must then be exposed to it for the space of two days" (*f*). Numerous other remedies, equally applicable to the ravages of the rice-weevil, are given by Harris in his well-known treatise.

a Curtis, Farm Insects, p. 79.
b Riley, 3d Ann. Rept. Ins. Mo., 1871, p. 108.
c French, 7th Rept. State Entom. Ill., 1878, p. 105.
d Riley, 3d Ann. Rept. Ins. Mo., 1871, p. 104.
e French, 7th Rept. State Entom. Ill., 1878, pp. 105–106.
f Harris, l. c., p. 507–509.